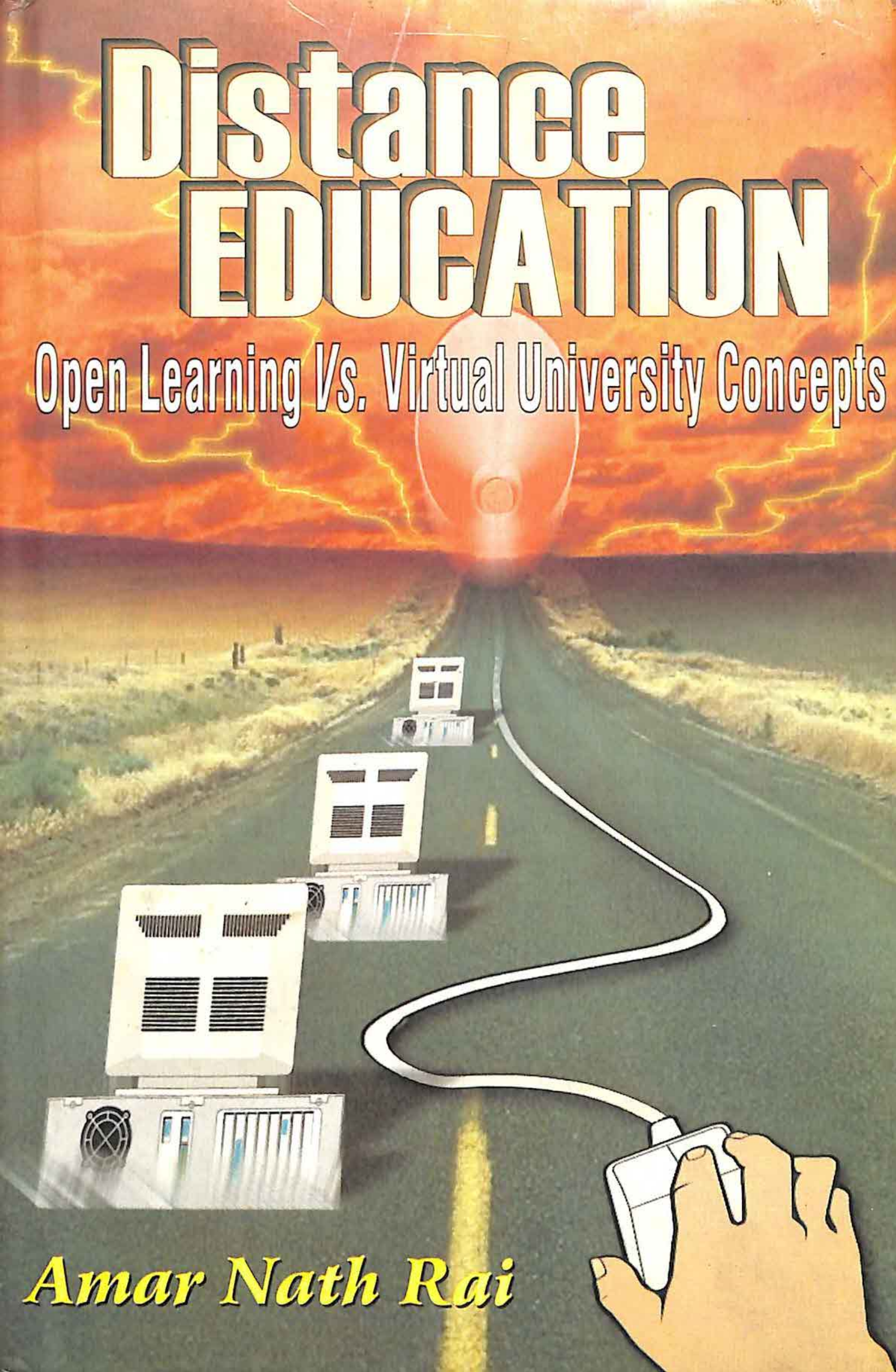
Distance EDUCATION

Open Learning Vs. Virtual University Concepts



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Vs
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The future of education in the world seems to be under attack in ways that ultimately will affect the overall quality of life for everyone. Nations must recognise that their human resources are their most valuable resources. Most developing countries are unable to produce engineers and technicians in large scale due to many reasons. There is also an urgent need, because of the high-tech revolution, to retrain and upgrade the engineering workforce already available in the country.

The conventional methods of teaching and educating engineers and technicians cannot cope with the scale and magnitude of these needs. A number of new initiatives have been taken recently with the main objective of making engineering education not only cost-effective but also accessible to a large number of people. These new initiatives are based on satellite delivery of courses from one location to another locations simultaneously.

Author

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1

Distance Education Concepts

Distance learning has taken systematic teaching-learning process to persons living in isolated areas where facilities for the traditional form of classroom teaching cannot be developed. Further, as distance learning addresses the needs of specific target groups, there is a great variation in the range of programmes offered. Consequently, the basic characteristics of distance education are spatial separation of the teacher from the learner, an age-heterogeneous learner group, easy availability and diversity in the nature of programmes offered.

Open education is a term that has been used interchangeably with distance education. It has been described as "arrangements to enable people to learn at the time, place and space which satisfies their circumstances and requirements". While distance education refers to the process of learning in which there is spatial, and usually temporal, distance between the teacher and learner, on the other hand open education (or open learning) refers to the process of making learning available to a learner at a place and time of his/her choice,. and at a rate suitable to the learner.

The term education also implies open access to learning regardless of previous qualifications or age of the learner. A third term which is being increasingly used is flexible learning. The National Council for Educational Technology defines it as "a means of making it possible for learners to gain access to education and training provision tailored to their needs and aspirations". Lockwood points out that with reference to learning systems 'flexible' has the same meaning as 'open', only that the former term emphasises the individual nature of the programme. The layman need not do much hair-splitting as far as terminology is concerned.

The professional view of Educational Technology (ET) is that it is an instructional system design that comprises both 'technology in education' and 'technology of education'. While the former involves the design of instructional devices by applying physical sciences and engineering technology, the latter includes the creation of technology of learning by applying behavioural sciences. Distance education is obviously concerned with both aspects.

Distance education in its earliest form utilised only the print media. Subsequently, in the period between the two World Wars projectors of different types and audio cassettes were added as teaching aids in formal (traditional) education and the latter made its entry in non-formal (distance) education also. A little later video films were added to the repertoire of teaching aids. The advent of the *techniques of the air* (broadcasts and telecasts) marked a clear divergence in the pathways of formal and non-formal education. The years following World War II saw rapid developments in the field of communication technology opening up new pathways in both formal and non-formal education, and especially in the latter.

The development of computer-based technologies has revolutionised teaching and learning process. Today, as we stand on the threshold of the second millennium the advent of virtual classrooms and video desktop (two-way audio and video) promises interesting possibilities, including the remerger of the formal and informal streams.

Educational technology visualises three strategies for the teaching-learning process. These are mass communication, individualised learning and group learning. All of these are currently in use. Mass communication involves the transmission of information and knowledge by an individual to a group, or groups, of varying sizes. In the classroom situation, where the number of students is manageable the teaching-learning process is facilitated by the use of relatively simple teaching aids like blackboard and chalk, books, visual aids like overhead and slide projectors, and audio-visual aids like films and video-cassettes. Because of developments in communication technology it is now possible to impart instructions to much larger number of students. The use of Closed Circuit Television (CCTV), for example, allows a lecture to be simultaneously delivered to different groups of students sitting at different places. The development of satellite technology has now made it possible to reach thousands of students in scattered locations through telecasts. Individualised learning led to the development of programmed learning materials that can be given to the individual learner, in small, logically structured frames. The structured materials that need individual learning needs may be in the form of print material, audio tapes, video cassettes, filmstrips and computer programmes. With the development of information storage devises like CD-ROM, the availability of multi-media and the incoming of internet individualised learning has the potential of becoming the most popular learning strategy, in both formal and informal education.

The dynamics of group learning shifts emphasis from hardware and software to techniques like tutorials, controlled group discussions, and simulation. As such technology is not important in group learning. However, tele-conferencing may become important at some point of time in the near future.

The *Correspondence Course Model* is the oldest and most stable model of distance education. As pointed out by Cantelon, the Chautauqua movement brought continuing education to millions of Americans long before anyone used distance education. Dr. Harper may, therefore, be regarded as being the father of modern distance education and the Chautauqua programme the prototype of the Correspondence Course Model. The printed word has been the dominant medium of delivery in correspondence programmes and will probably continue to be so in the foreseeable future. In India, nine Open Universities and

61 Correspondence Course Institutes (CCIs) attached to dual mode universities offer correspondence programmes almost exclusively through the print mode.

The syllabi of the programmes offered is the same as that of regular courses offered in classrooms, with the lectures being replaced by printed texts that may incorporate visuals. Interaction between teacher and student is through written answers submitted as a response to tests administered periodically. Some CCIs are, however, now making efforts to supplement the printed material with audio and video cassettes. The CCIs offer a wide range of programmes, ranging from undergraduate and postgraduate degree courses to diplomas and. certificates in professional areas.

The *Telecourse Model* was realised for there was the need to grant access to education to the poor and disadvantaged classes. As implemented, it consisted of a series of video lessons that were supplemented by a text and a study guide. With development of technique and technology the video lessons are now in the form of high quality documentaries broadcast to fit the schedules of general audience. The telecourses have greatly promoted adult and continuing education in the United States. In India, the telecourse model has not been utilised for imparting regular higher education courses leading to degrees or diplomas.

Programmes relating to both general themes and specific topics are being telecast on all weekdays on the national television network Doordarshan. These are the Countrywide Classroom (CWCR) and the Open Channel of Indira Gandhi National Open University (IGNOU), the target group being the undergraduate students. Individual programmes are of 18-30 minutes duration. About 80 per cent of the programmes are produced in India and the remaining 20 per cent imported keeping in view their high quality and relevance. For producing programmes of desired quality and content the University Grants Commission (UGC) has established seven Education Media Research Centres (EMRCs), and seven Audio Visual Research Centres

(AVRCs). The *Open University Model* has been designed keeping in view the need to widen access, especially for disadvantaged groups, to give quality higher education by providing a flexible and cost-effective system of instruction. The oldest open university is the University of South Africa, which started teaching at a distance in 1946, and the idea of a 'University of the Air' originated in Japan in the 1960s. It stemmed from a university lecture programme series of the Nippon Hoso Kyokais (NHK) conducted with the cooperation of 16 private universities of Japan.

The nomenclature 'Open University' was suggested by the Planning Committee set up for establishing the university in its report of 1969. The use of the adjective 'open' is possibly enigmatic, and certainly imprecise. It conveys a liberal attitude and, therefore, by implication flexibility. In the words of MacKenzie *et al.* 'open' carries "suggestions of the lessening or removal of restrictions, of exclusions and of privilege; of demolishing or lowering established barriers between subject areas; of enlarging and enriching the areas of activity and experience graded as educational". Further, it symbolises "a shift in the relationship between teacher and pupil towards that of student and adviser". Open universities and open learning, therefore, stand for access and equity, interdisciplinary, versatility, informality and student centrelines. In the open university programmes the course curriculum does not replicate the curriculum used for traditional programmes but is specially designed by course teams to meet the requirements of students learning at a distance.

The approach towards course development is characteristically interdisciplinary. The delivery is through different delivery media including print, audio and video cassettes, telecasts, interactive TV, tele-conferencing, computer software and e-mail. Extra support is provided to learners through Student Support Services (SSS) like study centres counselling sessions, and evaluation of Students' Assignment Responses (SAR), and there is formative as also final evaluation. In the case of open universities in India the presentation of the subject matter is largely through specially developed print material, but also through a limited number of audio and video cassettes, and a few supporting telecasts. The contact between students and tutors is through written correspondence, and face-to-face sessions at study centres.

The *Distributed Classroom Model* has its genesis in the need to offer popular courses to a large number of students sitting in different classrooms using close-circuit television. Initiated in the 1950s, in the United States, as a one-way system the model received impetus in the early 1990s with the introduction of interactive, compressed, video telecommunication systems. It facilitates distance learning for groups at off-campus locations in a live situation. However, the time and pace of study is under the control of the educational institution. This model is rarely utilised in India, the problem of large numbers being attended to through the formation of different 'divisions'—the same course being taught in different classrooms, usually by different teachers.

DISTANCE EDUCATION SYSTEMS

There are three types of distance education system (DES), viz., institute-centred, person-centred and society-based. In the institute-centred DES there is a predominance of systematic models of education. The institutional mission focuses on the cost-effectiveness and cost-efficiency of the system. Academics become consultants to the institution for material design and development. All other functionaries in the institution are assigned key functions with accountability and individual responsibility.

In the person-centered DES the programmes are more individualised and negotiable as the aim is to serve the individual learner. Individualised learning is personally negotiated and is followed up by tutors/counsellors. In the society-based DES learning materials are developed in accordance with the needs of the community. These are used in community situations where the teacher strives to involve the entire community in the study of the learning materials. The teacher functions as a facilitator for the identification learning goals, learning materials evaluation, mechanisms and the like.

A nation like ours that has adopted the promotion of the welfare of its citizens as its clearly defined goal cannot remain content with the formal type of education that has existed over the past century and a half.

The traditional single channel or full-time formal education has turned out to be both selective and prohibitive, and is, therefore inadequate to encompass the potential for development that has enthused and enthralled our progressive farmer in rural areas and socially conscious workers in industrial and commercial establishments. It has miserably failed to give any concrete shape to the philosophy of ensuring equal educational opportunities to citizens of all age and class groups.

A viable alternative hence specially in developing countries like ours is to throw open the gates of learning using the non-formal, correspondence/distance education or open learning. This method of education, conducted in different ways, is assuming widespread proportions the world over. Its growth can be traced to the Correspondence Courses of the 19th century and to the use of instructional technology in the 20th century. At the 11th World Conference organised by the International Council of Correspondence Education, the President of ICCE, while dwelling upon its advantages, maintained that it is highly adaptable to the circumstances of a particular student.

Moreover, it is probably the most cost-efficient method of education available to them and is accompanied by the advantage that one can learn while he is earning, i.e., he can both gain experience and earn his living at the same time thereby becoming the bread winner for his family. Another advantage of the distance education mode is that it is devoid of any rigid formalities of age and attendance. Correspondence/Distance Education was therefore started in our country by the University of Delhi on an experimental basis in 1962. It is in this sense that the Directorate of Correspondence Courses, University of Delhi, became the pioneering venture in the field of non-formal education in India. Its success led to the start of many other schools, institutes and directorates of correspondence education and today there are 61 of them besides eight State Open Universities, a National Open School and a National Open University. Combined, they are playing a momentous role in the domain of higher education in our country. The students enrolled herein comprise not only the in-service personnel, but also those who could not secure administration due to paucity of seats or are working in remote places. The pursuit of studies through distance education helps these men and women to spend time well and wisely, and also to come into contact with well informed and educated people. It also enables them to improve their employment potential and find better jobs.

Distance teaching, like any other of its forms, is based on the general laws of motivation, stimulation, assimilation and application which constitute the core of all human learning. Teaching through correspondence has to keep this in mind, and this in our country is done largely through a composite process, comprising despatch of study material, correction of response sheets by way of feedback operation, imparting a personal touch through counselling and Personal Contact Programmes, and imparting knowledge through the electronic media such as audio-video methodology.

The preparation and mailing of study material is fundamental to the scheme of things. Though it invariably proves adequate, in some cases, the study material alone is not sufficient to galvanise the interest of students who are either average or below average. A practical problem also arises if the study material is not updated, revised, reviewed or rewritten at regular intervals. This is specially true of areas where the information and knowledge is growing very fast. It has been observed that some institutes are still sending material written in early 1980s even on a fast changing paper like 'Indian Government and Politics'. It is not difficult to imagine the inadequacy of the knowledge of our students if this is the status of study material provided to them.

It is pertinent to mention that some institutes of correspondence courses have recently experimented with the use of computers, transferred their study material of the floppies and updated the same according to requirement. However, the percentage of such institutes is negligible. The response sheets which are intended to provide the feedback operation are indeed the worst calamity in the distance education methodology. They are scarcely checked and rarely returned back to the students. Gradually, the students also loses interest in writing the answers and sending the same for necessary corrections and evaluation to the institutes.

A personal touch or face-to-face contact between the teacher and the taught is provided through counselling or personal contact programme. Colleagues from the universities and institutes of distance education where counselling has been introduced, opine that it has not been able to serve the purpose which it is intended to serve. While Counselling aims at clarifying the doubts that arise in the minds of the students, Personal Contact Programme serves a dual purpose of imparting classroom education while removing doubts and giving clarifications on the study material provided to the students.

The importance of personal contact programme has steadily increased and it has become the second important tool of correspondence education. Through Personal Contact Programme classes, the students establish a rapport with the teacher and the programme helps fasten the pace of learning by providing them with an easy access to the understanding of their study material. But the protagonists of conventional type education have often challenged the efficacy of personal contact programme, particularly in the Third World countries. A developing country like India, they opine, cannot afford to make effective use of satellite, radio, television, internet and e-mail and other recently developed technologies for providing a meaningful contact with the students. It is also observed that the personal contact programme faces both administrative and academic problems. It requires a careful planning so that this facility is universalised and covers all the students enrolled with a particular institute.

Faulty planning can deprive a good number of students of the benefit of this contact which is a vital link in the process of learning. Moreover, this programme can become effective and meaningful only if the study material is handed over to the student at the time of his admission or latest within a month of the declaration of his result. The success of this programme entails that the students should have gone through the study material and should have earmarked their problems in understanding certain difficult portions, well before the personal contact programme starts.

Unfortunately, owing to various administrative or academic reasons, the schedule is not adhered to religiously. It is also essential that a chain of adequately equipped study centres along with library and reading room facilities are provided at the places where the students attend their personal contact programmes. This definitely will go a long way in supplementing their study material with standard text and reference books and meet the urgent academic needs of the students besides being elevating in itself. Unfortunately the study centre facility has largely been ignored in most of the personal contact programme centres. It is advisable that the distance education institutes spread over the various parts of the country should cooperate to accommodate the students on a reciprocal basis. This will be highly appreciated by one and all.

One therefore certainly hopes that we, the participants take up the social responsibility of turning out well-informed students. It would be sad, if universities do not extend all out help towards accommodating and extending suitable facilities to a correspondence course/distance education institutes from other areas. It is also essential that the administrative staff that helps in the organisation of the Personal Contact Programme should be equipped to answer the queries of the students in respect of matters of combination of subjects, scope of syllabus, fees and other charges, the dates of examinations, etc.

Besides teaching, the teachers should make themselves available for meaningful discussion with the students not only with a view to help them overcome their academic difficulties, but also to equip them face the challenges of life with calmness and fortitude. This would also enable the students to cultivate relations with their gurus and provide them with trusted friends and guides.

Now, distance education does not solely rely on print, it also lays emphasis upon the use of high speed communication and information technologies as delivery system. A very important input in the distance education methodology hence is the introduction ànd application of multimedia and other technological advances adopted by the developed countries. Information technology is not just a technology, nor is it merely a new enabling tool for economics and education. Rather it will lay basis for a whole new global civilisation in which Indian values and wisdom will play a defining role.

In the academic arena, the conventional classroom status alone has failed to cope up with the sudden explosion in the number of students. This system was therefore sought to be supplemented by the correspondence/distance education institutes within the framework of the conventional universities. But, can a Third World country like India afford to blindly adopt the techniques developed in the west for imparting learning through distance education? The fact is that we do not even have electricity in many rural areas and consequently these technologies cannot be applied universally. Moreover, introduction of high technology needs huge investments in infrastructure and equipment, i.e., it calls for a diversion of funds, which as it is, are scarcely available.

Another aspect of distance education is the issue relating to administrative inputs. On the basis of our experience, we all know that the quantum of administrative work in a distance education institute is very high. Administrative work here embraces admissions, issuing fee receipts, identity cards, distributing/despatching study material, examination forms, roll numbers, examination centres, results, mark sheets, provisional certificates, enrolment numbers, degrees, migration certificates to name only a few. This quantum has steadily increased owing to a proliferation in the number of students we have to cater. It has been noticed that some administrative staff members, at times, lose their patience while dealing with the students. Some students consequently get disappointed and this explains why the rate of dropouts is quite high in the distance mode. While the importance of computerisation of students, services cannot be underestimated, we must try to exchange views on our experiences in this direction and try to benefit from each other's success in this regard.

Objectives

The distance education mode was started with specific objectives to be achieved which are:

- to provide a system of student-centred, self-paced learning.
- to provide a flexible, diversified and open system of education.
- to develop by providing wider access to higher education to persons of all ages and particularly to working persons and economically and otherwise handicapped, and persons residing in remote areas.
- to provide means of upgrading the skills and qualifications, and
- to develop education as a lifelong activity so that the individual can refresh and update his knowledge in an existing discipline or to acquire knowledge in new areas.

The advantages of this system is to provide the learner a choice to continue education as a part-time and pastime activity at his own pace, place and time. There are no two opinions over the usefulness of this system, particularly in a vast country like India to literate its people faster and make higher education accessible. Coming to the actual functioning of these centres some problems are yet to be resolved. A majority of distance education centres and schools of correspondence courses of the conventional universities do not have autonomy and freedom to experiment with new courses or the syllabus of the existing courses.

In the absence of proper linking of the distance education systems of the country and with no autonomy to introduce the new courses, these centres are functioning simply as appendages to the regular system of the university. Lack of uniformity among admissions, courses, and staff pattern is reducing the efficiency and quality of the system.

There is a peculiar problem for the students of Dr. B. R. Ambedkar Open University where they have just 100 marks for language papers in part-I. The students who graduate from this university are enthusiastic to do PG courses with English or Telugu or Hindi. The rule of the conventional universities is that the student should have appeared for two papers of 100 marks each in English or second language. So a student of Dr. B. R. Ambedkar Open University becomes ineligible to apply for M.A. (English) or (Telugu) or (Hindi) in the Centre for Distance Education of Osmania University—both the universities being situated in the same city. For no fault of his, the student is penalised. An anomaly like this would defeat the very purpose of providing flexibility in the distance education system. Calling these degrees on par with those of regular universities, the students of the state open university are thrown into unredeemable disadvantage. The distance education centres have to be at the mercy of the Board of Studies (BOS) to get any new courses approved or to change the course design of the existing courses. As most of the BOS members are from the regular college/university system it is difficult for them to evaluate the needs and difficulties of distance learners.

The pattern of recruitment of teaching staff, their designations and nature of work differ widely in the distance education centres; some call them Co-ordinators, some Assistant Directors and so on. Can we evolve a uniform pattern for all the distance education centres with regard to the teaching staff at the centres? An urgent need is felt to introduce some ratio between the number of students and the number of faculty members in a particular discipline. Many times, there may be 5,000 registered students in a particular subject without any teaching faculty at the centre. To meet the needs of learners more effectively, the staff in the concerned subject should be available at the distance education centres. So let the UGC and Distance Education Council fix a uniform staff pattern, proportionate to the number of students in the different subjects.

Even the existing discrimination in terms of promotion may be erased to encourage the teaching staff to join the distance education centres. Even the quality of the study material could be ensured if a member of that faculty looks after the preparation and updating of the course material. The inadequacy of the present distance education centres in their staff reflects on the quality of its products. The standard and quality of the distant learner depends on the study material which need to be constantly update and revise as per the changes in the syllabi.

Contact Programme plays a significant role in the learning process through distance education system. There appears to be no uniformity either in the time or the number of periods allotted to the subjects. A uniform system should be evolved to conduct these classes more regularly and effectively. Again, for the conduct of the contact programme, the distance education centres are depending on the regular departments of the universities. If a panel of teachers could be chosen from various colleges around, the contact programme may be conducted more effectively.

The Distance Education Council and IGNOU have to present the course materials of the distance learning in an effective self-instructional mode; there is no uniformity among the materials of different distance education centres. As the course material should compensate the absence of regular teaching for the learner, a uniform and effective pattern should be evolved for presentation of the materials. Even here, in most of the cases materials are prepared by the teachers from conventional system who do not have necessary time and accommodation to meet the needs of the distant education learners. If more workshops are conducted faculty-wise to train the faculty for preparation of Self-Instructional Material, it will be useful to the learner.

The examination system is a very important aspect of learning process. The syllabus, examination papers, evaluation—all these are on par with the regular system. The examinations are also conducted by the respective universities.

A common core syllabus throughout the country helps to pool the materials and prepare standard materials in English which facilitates their translation into respective state languages. All the distance education centres along with the open universities conduct regular seminars and workshops to work more closely and effectively. These enable to update the developments that occur in the distance education centres. We are providing an opportunity to obtain knowledge and degrees to our learners. But most of the distant learners are very poor in their communication skills, both in English and their native language. Offer a course in Communication Skills in English and their native languages in all our centres, so that the interested students could do it simultaneously. Necessary guidelines are to be evolved to have uniform eligibility criteria for admission into various courses offered in distance education.

To develop staff structure to run the distance education centres effectively and improve quality of education through this mode, provide training facilities by conducting workshops, refresher courses, short-term courses for the staff working in distance education system. Guidelines should be issued to all the universities for developing academic, administrative, financial and functional autonomy. Proper encouragement should be given to all the distance education centres for developing the need-based and professional oriented curriculum which suits the native environment of the learner. The government, UGC, Distance Education Council should come forward to sanction liberal grants for the development of the distance education system.

2

Distance Learning Environment

Distance Learning Environment is an evolving paradigm of instruction and learning that attempts to overcome both the distance and time constraints found in traditional classroom learning. It is a set of technologies that can allow for a more equitable distribution of resources, as well as a more personalised learning experience type of educational concept offers instruction that, depending on the kind of system or technology, has most or all of the following characteristics: it is self-scheduled, self-motivated, and self-paced, there is no travel time; and it retention, continuous availability, and a non-threatening learning environment.

Solid-state electronic advances made possible a major growth of cable TV systems, satellite communications and computation power. Increased precision of electronics in view of the development of digital circuitry and mass production of integrated circuit chips resulted in many new functions, lower prices, and better quality and reliability for communications systems. The educational community, however, has been relatively slow in adopting the potential, power of the new telecommunications systems. The use of computers as a tool for delivering education was implemented and experimented with in the late 1970s and early 1980s. Politicians and government-allocated money for computer education, and educational software packages proliferated. Those packages followed, for the most part, a programmed learning paradigm that emphasised drill and practice. Boring, unimaginative software was largely to blame for the failure of the computer as a learning tool. By the end of the 1980s, when better software became available, publishers were uninterested, and teachers were dubious and afraid of the high cost of computer technology. It was only in the early 1990s that telecommunications-based education started to realise its potential, especially with the advent of high-power personal computers (PCs), broadband communications, and digital video.

This chapter discusses the educational challenges that face contemporary society. It introduces the concept of distance learning and presents the key drivers of, and the inhibitors to the growth of the distance learning industry.

Education and training are strategic tools that a society needs to continuously apply in order to sustain a global competitive advantage and to create a better standard of living. While corporations need to upgrade the skills of their employees, government agencies at the federal, state, and local levels need to deal with the problem of structural unemployment. That problem, which affects five million to six million blue-collar workers in the United States, is a result of the transition of the economy from a labour-intensive economy to a skill-based economy.

Structurally unemployed people lack skills and need to be retrained so they can rejoin the American workforce. Another major challenge facing the US government is how to convert the welfare system to a "workfare" system. Welfare recipients have no hope of joining the workforce unless they acquire basic skills, such as reading and writing. At the time of the writing of this book, a major item on the agenda of the 104th Congress was to develop welfare reform legislation. Any welfare bill that passes Congress and is approved by the President cannot succeed in addressing the nation's educational problems unless it deals explicitly with two interrelated problems: retraining welfare recipients and curbing illegal immigration.

CHALLENGES FACING UNIVERSITIES

Universities are faced with their own set of problems. First if they follow the traditional approach in delivering education, they must continue to incur the cost of building new campuses and maintaining existing ones. Another key challenge is the increasing cost of education. University tuition is on the rise, outpacing inflation. A third problem facing most universities is the declining interest of some graduating school students in obtaining a college education. This is forcing universities to formulate strategies to enable them to compete effectively with other universities to attract high school graduates.

The decrease in potential population, due to natural demographics, has forced many institutions to undergo self-examination. Technology is one of the methods being brought to bear to support quality teaching. As colleges and universities become increasingly market-driven, they are targeting students not on the basis of geographical proximity but on the basis of interest in programmes.

Distance learning technology affords access to a sizable market of nontraditional students who are older, have family responsibilities, are employed, wish to remain in their geographic areas, and need continuing education to succeed more effectively at work. A fourth problem is the declining support from the federal and state governments. For example, State University of New York administrators recently announced that if the cuts proposed by the governor were approved by the state assembly, the university would be forced to close a number of campuses throughout the state.

ROLE OF DISTANCE LEARNING

Distance learning has become an option because of the increasing availability of higher-speed, two-way digital telecommunication facilities. Fibre based terrestrial networks are available in most US markets and advances in digital video compression means that a "low-end" DS1 line is adequate for many distance learning applications. In addition, satellite-based networks cover nearly the entire US although two-way connectivity is difficult to achieve directly, a return path can be secured using a dialup voice/data line. The bottom line is that the growing availability of connectivity options is positively influencing educational institutions' adoption of distance learning. The road to the goals of an equitable, technology-rich education system requires a number of initiatives. IDL is one the technological tools that can contribute to the solution of the educational problems that society faces.

IDL refers to a portfolio of application and networking solutions that can be (and are being) implemented by universities, K-12 schools, corporations, and government agencies to enable them to enhance the education and research process. IDL solutions establish telecommunication links between education receivers and various sources of knowledge over geographic areas that may span a metropolitan segment, a whole state, or the entire country. These sources of knowledge are not limited to distance learning providers, such as universities and corporate training centres; they also encompass information and processing resources, such as libraries, supercomputer centres, and museums. The required links may involve voice communications, video communications, data communications, or a combination of these media. The quality of the distance learning programmes is a function of the selected type of solution and the particular needs of the distance learners.

IDL solutions can address many of the challenges facing education and training institutions. The following examples are only a few of the benefits that can be accrued.

- IDL can reduce the isolation of rural K-12 schools and colleges, and it can address anticipated shortages of teachers in those communities by linking them with education providers.
- IDL can eliminate the electronic isolation of the traditional K-12 classroom by linking classrooms with external sources of learning, such as museums, libraries and universities.
- IDL can enhance the quality of education by speeding the process of information transfer between education providers and education receivers.
- IDL offers the promise of instant sharing of information among members of the R&D community, speeding the research process and, consequently, the development of new products and services.

- IDL can resolve some of the financial problems facing universities by providing them with economics of scale. Through distance learning, a greater number of remote classes can be created, giving education providers the opportunity to generate more revenues per teacher or to reduce the tuition per student.
- By implementing distance learning solutions, a university can differentiate itself from other universities by being at the leading edge of technology.
- Through distance learning, government agencies can reduce the cost of retraining the structurally unemployed and welfare recipients.
- IDL enables corporations to upgrade the skills of their workforces to effectively compete in skill-intensive industries.
- IDL can reduce the training budgets of corporations by reducing costs of travel for educational purposes.

Educators and administrators who appreciate the positive value of telecommunications are investing school capital and operating funds in IDL technology; in many schools and colleges, telecommunications has become a line item in the operating budget.

Interstate networks and entities

Some of the key interstate IDL programmes are listed below.

Agricultural Satellite Corporation (AGSAT) is a consortium of 42 university affiliates and two government agencies. Both non-credit and credit courses are delivered via satellite to sites in 40 states. In addition, agricultural and agribusiness research information is disseminated.

The Annenberg/CPB Project was established in 1981 and is based at the Corporation for Public Broadcasting. The original charter was to assist in the improvement of and access to higher education. The Project has funded high-quality video telecourses as well as new technology projects. More recently, the Project has adopted the goal of spearheading the reform of maths and science education through technology.

Oklahoma State University created the *Arts and Science Teleconferencing Service* (ASTS) in 1988 to oversee K-12 programming. ASTS is a partnership of rural school administrators, the Oklahoma Department of Education, and the College of Arts and Sciences at Oklahoma State University. ASTS provides live school programming via satellite in math, science, and language to approximately 425 schools; the ad hoc programming reaches more than 900 institutions.

The *Black College Satellite Network* (BCSN) includes 65 school districts that participate with black colleges and universities to receive educational programming.

Cable in the Classroom is a non-profit service supported by the cable TV industry. It offers free service to all K-12 schools passed by cable facilities. The service includes noncommercial programming, support materials, and copyright-free use of those material.

Channel One is a satellite-delivered daily news and information programme reaching over 12,000 K-12 schools. The free 12-minute programme includes two minutes of commercials.

Learning Links is a national consortium of 22 agencies linked under the Central Educational Network. The service, which is available to K-12, supports online access to databases, bulletin boards, and e-mail.

The *Massachusetts Corporation for Educational Telecommunications* (MCET) was established in the early 1980s and is funded by the state legislature. It distributes as well as produces K-12 instructional programming over a satellite network (Mass LearnPike) and over a computer network (Mass LearnNet).

The *Mind Extension University* (ME/U) delivers educational programming nationwide in cooperation with cable TV systems. ME/U provides credit-based undergraduate and graduate courses from a number of universities.

The *National Distance Learning Center* (NDLC) acts as a centralised electronic information source. It keeps detailed listings of teleconferences and K-12, higher education, and continuing education courses.

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The *National Telecommunications and Information Administration* (NTIA) is part of the Department of Commerce. It acts as the President's advisor on telecommunications policies, particularly as they relate to the nation's economy and technological base. NTIA funds the Public Television Facilities programme and the Telecommunications Information Infrastructure Assistance Programme (TIIAP). TIIAP, which started in the early 1990s with a $26 million fund to assist educational institutions, has reviewed-over 1,100 proposals for IDL programs.

The *National Technological University* was founded in the mid-1980s and now includes 45 participating universities in the United States. Over a dozen master of science programmes in engineering are provided by satellite to full-time employees and federal workers. The programming is received at over 430 sites (universities, corporate offices, and government locations), with more than 100,000 students.

The *Public Broadcasting Service* (PBS) funds and distributes televised instructional material. It offers telecourses to about 2,000 colleges and universities, in cooperation with local public television stations, through its Adult Learning Service and the Adult Learning Satellite Service. PBS also offers the Elementary/Secondary Service, aimed at K-12 schools.

The *Satellite Educational Resources Consortium* (SERC) involves state public broadcasting entities and departments of education in 25 states. It also develops instructional and professional programming.

The *Satellite Telecommunications Educational Programming* (STEP) delivers live, interactive education over satellite links.

The *Star School program*me was authorised by Congress in 1988 and is over-seen by the Department of Education. The programme disseminates awards, grants, and support for a number of IDL networks, including Iowa's statewide system, SERC, BCSN, and STEP. Other channels include the Technical Education Research Centers, and the Telecommnications Education for Advances in Mathematics and Science (providing nationwide math programming for students in grades 4, 5, and 6).

The *United States Distance Learning Association* (USDLA) promotes the development and application of IDL using satellite, video, audiographic, and multimedia technology. It spans K-12, higher education, continuing education, and corporate training.

The *Western Cooperative for Educational Telecommunications* includes more than 150 corporations, universities, colleges, schools, and public agencies in 19 states. Its charter is to make information and expertise telecommunications more easily available to its membership.

There are many state-level IDL initiatives. States are considered to be the fulcrum for planning in education. Most of the significant education policy emanates from the state capital, either from the, department of education for K-12 schools or from the board of regents, higher education-commission, or state university system. This state-centric paradigm also applies to IDL. It should be noted that in the past couple of years only a few states have increased their funding of IDL.

Most states continue to be financially disadvantaged, particularly in view of the 1995 budgetary reforms initiated in Congress, Nonetheless, in most states legislators, administrators, and regulators are collaborating to identify new ways to fund applications through matching programs, incentive regulation, and taxes to generate funds. For example, Missouri's VIDEO programme relies on a videotape rental tax. Other states (e.g., Georgia and Michigan) have created new telecommunications rate regulations that are favourable to IDL.

STRUCTURE OF THE DISTANCE LEARNING INDUSTRY

Many distance learning communication solutions are on the market today to satisfy the needs of distance learning providers and receivers. These application solutions can be divided into two categories: video solutions and data solutions.

Video solutions can be further classified into four categories: One-way video/one-way audio; One-way video/

two-way audio; Two-way video/two-way audio; and N-way video/N-way audio with continuous presence. It should be noted that, despite the drive toward digital technology and fibreoptics, a major portion of distance learning programming is still carried by analog satellite links (although the use of compressed digital video is compelling) microwave links over-the-air and cable analog TV, and instructional television fixed service (ITFS). Once such recognition is made, one can then focus on an assessment of the advantages of a migration to digital.

K-12 schools can access educational TV programmes by subscribing to basic cable TV services or obtain them over an ITFS network. For example, students and teachers can access educational programming about computers, communication, multimedia, software and related matters through the Jones Computer Program. They can also watch cultural lectures, debates, and symposia through the Horizons Cable Network. In addition, they can have general education and enrichment programming through the Learning Channel. Students can also monitor world events on Cable News Network (CNN), which provides news coverage 24 hours a day.

One-way video/two-way audio solutions are predominantly satellite-based and enable distance learning providers to establish a one-way video/two-way audio with the recipients. While the video programme originates at one site, the distance learning receivers can be located at multiple sites. Transmission is either analog or digital. Traditional analog TV requires 6 MHz; digital transmission rates range from 3 to 6 Mbps. Video broadcasting systems can be classified into two categories:

- *Private-business TV-based programming* (e.g., specialised training, seminars). These systems are used by corporations internally, for example, to provide corporate training.
- *Shared institutional distance learning systems*. These systems are shared by multiple distance learning receivers (e.g., universities, corporations) and are managed by a single distance learning provider.

> Examples of satellite-based distance leaning systems include BCSN, the National University Teleconferencing Network, the National Technological University, and Wescott Communications.

Two-way video/two-way audio systems provide participants with simultaneous interactive image and voice communications, enabling individuals in different locations to communicate with each other as if they were in the same room. Users may be students communicating with their teachers over a long distance or executives communicating with their employees.

Video-conferencing systems involve the transmission of two-way video and two-way audio from one location to multiple locations. To reduce the amount of bandwidth required for transmission, digitisation and compression of audio and video signals are implemented. One company with a full-motion two-way video training network is Bell Communications Research; an example of a compressed-video two-way video training network is Teleport Communications Group. Video/video-conferencing systems can be classified into four categories: Custom or site-built rooms, Standalone units, Rollabouts and Desktop systems.

Custom or site-built rooms, including classrooms, are equipped with fixed systems to support video communication. Equipment is often built into walls or tabletops. The number of participants accommodated by this design is usually a function of room size and layout. This system represents the high range of video/video-conferencing systems and is appropriate for corporations that have made a major commitment to video-conferencing.

High-end systems can support executive level video-conferencing usage, and complex applications that require significant peripheral equipment. These rooms are used by both educational institutions and corporations, although the venue, the design, and the audio/visual systems tend to be different. Education institutions particularly need the following: simple control systems; monitors and projectors ranging in size from 27 inches to 53 inches (or more); three or more cameras per system (one for the student, one for the instructor, and one for graphics capture); a high-quality audio system, including quality microphones and speakers; and direct computer peripheral input to the audio/visual system.

Standalone units usually are stationary, cabinet-mounted units that contain the major equipment required for video/video-conferencing. Standalone systems accommodate the same types of applications and the same participants as custom-built rooms. Standalone units, however, offer a less costly and less permanent solution. These systems can be used by both educational institutions and corporations.

Rollabouts are configured on carts with staging rooms for storing peripherals. These systems, which represent the midrange of video/video-conferencing systems, have two advantages: (1) They are convenient because of their transportability and flexibility, and (2) they are more affordable than high-end systems. These advantages make rollabouts appropriate for companies with limited space, moderate budget and video/video-conferencing needs which may be dispersed throughout a specific location. These systems can be used by both educational institutions and corporations.

Desktop systems are intended for use at employees' desks or in small meeting areas. They currently represent the low end of video-conferencing systems, making them the most affordable. PC-based video/video-conferencing systems can be created by connecting PCs to local area networks (LANs), which are extended to wide area networks (WANs) through services such as switched, digital services. PCs can also be connected directly to WANs.

Although classrooms tend to have multiple monitors, many (corporate) video/video-conferencing systems rely on one monitor to display both the incoming and the outgoing video images. This is accomplished through windowing, whereby a small window displaying one image (usually outgoing video) is superimposed on the main window (usually displaying incoming video). Alternatively, dual windows can display incoming and outgoing video or incoming video and graphics simultaneously. The number and set-up of monitors depends on the application, the room characteristics, and the type of video-conferencing installation (e.g., desktop, rollabout, custom-built). Large monitors tend to be more effective.

The number and the arrangement of cameras depends largely on the number of conference participants, students, or teachers; the application requirements; the room characteristics; and the type of video-conferencing installation (e.g., desktop, rollabout, custom-built). Cameras range from low-end systems, to on-charged-couple-device (1-CCD) systems with 470 lines of horizontal resolution, to 3-CCD cameras with 750 lines of resolution. Cameras can be positioned in one of three ways: with a joystick or control panel buttons, automatically to focus on the participant who is speaking, or manually.

Audio quality is as important as picture resolution. Audio systems, including speakers and microphones must provide clear, simultaneous two-way communication. One desirable feature of an audio system is automatic echo cancellation, which adjusts the incoming and outgoing audio signals according to the acoustics of a particular room.

A codec performs two functions: video digitisation and compression. Digitisation is the ability of the codec to convert analog video and audio signals into a digital bit stream for transmission over digital lines. When receiving the coded signal, the remote codec reconverts the digital signal back into analog video and voice signals, which are then sent to the video monitor and speakers. The codec also compresses the signal to provide efficient and cost-effective transmission.

Typically the compression ratio is 100:1. The level of picture resolution provided by the codec depends on the sophistication of the digitisation and compression algorithms. Video compression algorithms are based on the International Telecommunication Union-Telecommunication (ITU-T) or International Organisation for Standardisation (ISO, after the French) standards. ITU-T's standard H.261 covers transmission of video at rates ranging from 56/64 Kbps to 2.048 Mbps. ISO's Motion Picture Expert Group 1

(MPEG-1) supports entertainment-level video at 1.544 Mbps; MPEG-2 supports even better quality at 6 Mbps. The Motion joint Photographic Export Group (M-JPEG) supports quality video at 10-20 Mbps.

Video signals contain a substantial amount of intrinsic redundancy, so that compression can be undertaken prior to storage or transmission. Compression schemes that are able to reduce the raw bits by a factor of 100 or 200 are usually employed. There have been claims of compression ratios of 1:2,500 through the use of *fractal* methods. Audio/visual distance learning systems are not inexpensive and may typically require a system integrator to assemble and test.

Data solutions can be classified into two categories: Groupware, which allows remote training through PCs connected to the training site by a switched or permanent network, usually employing computer-supported cooperative work (CSCW) software and *internet*, which supplies ad hoc access to information and databases.

Groupware refers to software that can support at least one of the following applications: electronic messaging, data conferencing, or messaging gateways. Groupware solutions link distance learning providers and receivers that are separated by a WAN. An increasing number of vendors offer groupware. Providers of groupware solutions extend beyond software providers (e.g., Lotus) to encompass network providers (e.g., MCI and AT&T).

The internet has been growing rapidly in the last few years. Through the internet a user can receive a number of services, including logon services, e-mail, file transfer, host-to-host communications, and directory services. Recently, the internet has "burst into the collective consciousness of the American business community, triggering exponential growth".

SOLUTIONS

Communication systems are specific to topological segments of the network, for example, the access, the local-access transport area (LATA) backbone, and the national backbone, in the sense that different technologies may be employed in each segment. Topologically, communication occurs at the following levels:

— A local- or campus-area network, that is, within a building or within campus;

— Public network access, that is, between the user's building and the carrier's point of presence, for example, a local central office;

— A metropolitan area network (MAN), that is, at the community level;

— A WAN, that is, regionally or nationwide; and

— A global area network, that is, internationally.

Each segment of a communication link often utilises distinct technologies. In addition, each segment is subject to different cost, performance, and availability considerations. By and large, LAN issues relate to initial wiring and the deployment of appropriate servers. Bandwidth generally is not an issue, since one can obtain from 10 to 100 Mbps using traditional methods. Also, cost tends not to be an issue, since after the initial install (say, \$400-\$600 per connected workstation), there are no recurring charges.

Access to public networks is currently a major area of discussion as it relates to carriers efforts to improve it (access is what has been called metaphorically "the ramps to the information superhighway"). The factors of this discussion are: (1) the number of access lines in a network, which tracks with the number of residences and buildings requiring connectivity; and (2) the throughput of the access medium. Currently it is difficult to obtain more than 128 Kbps for a residence or more than 1.544 Mbps for a business. New applications, such as distance learning, require more bandwidth.

The media to support access include twisted-pair copper lines to the domicile (the staple of today's network), coaxial cable (e.g., cable TV companies), end-to-end fibre optic links, and hybrid fibre-coax systems (e.g., newer cable TV distribution systems). Existing technologies have limited throughput but are relatively inexpensive (e.g., 128 Kbps and \$600 to install per location); newer technologies support much higher throughput but are more expensive, particularly in view of the number of businesses and residences that would have to be upgraded (e.g., 2-10 Gbps on fibre, with an install cost of $2,500-$4,000 per location).

Technological variations are now being sought to increase bandwidth in a cost-effective manner. For example, there are ways of increasing the throughput of a twisted-pair copper line and ways of better utilising a fibre (e.g., using wavelength division multiplexing). The issues related to MANs and WANs centre on bandwidth availability, cost of the connection, and effective support of multiple locations. From a target-market perspective, communication solutions can be classified into the following two major groups: networking solutions that can support large and medium-sized businesses and networking solutions that support local communities.

Large and medium-sized business networking solutions can be classified into the following:

— Dedicated services, ranging in speed from fractional digital signal (DS) 1 (multiples of 64 Kbps, up to 1.544 Mbps) to a synchronous optical network (SONET) (multiples of 155 Mbps);

— Circuit switched services, which include switched DS1 (1.544 Mbps), and switched DS3 (45 Mbps) services;

— *Asynchronous transfer mode* (ATM)-based solutions, which include ATM cell relay service, as well as support of switched multimegabit data service (SMDS) and frame relay service (FRS) over the same integrated platform;

— Discrete fastpacket services, which include SMDS, FRS, and native-mode LAN interconnection service (NMLIS); and

— *Integrated services digital networks* (ISDN), which range in speed from 64 Kbps to 1.544 Mbps (DS1).

"Private line" digital services provide transparent bandwidth at the specified speed (n × 64 Kbps for FDS1, 1.544 Mbps for DS1, and 44.736 Mbps for DS3) and are suitable for point-to-point interconnection of low-burstiness (i.e., steady) traffic. DS3 facilities are increasingly available in many parts of the country, although they are still relatively expensive. In addition, a number of carriers have started to offer a fractional DS3 service that allows the user to specify the desired number multiple of DS1s. These dedicated facilities can support voice, video, and data.

Frame relay service (FRS) is a data communication service that became available in the early 1990s. It supports medium-speed connections between user equipment (routers and private switches in particular) and between user equipment and carriers' frame relay network equipment (i.e., public switches). The frame relay protocol supports data transmission over a "connection-oriented" path; it enables the transmission of variable-length data units, typically up to 4,096 octets, over an assigned virtual connection. FRS provides interconnection among n (backbone) sites by requiring only that each site be connected to the "network cloud" via an access line (compare this with the $n(n-1)/2$ end-to-end lines required with dedicated services).

The cloud consists of switching-nodes interconnected by trunks used to carry traffic aggregated from many users. In a public frame relay network, the switches and the trunks are put in place by a carrier for use by many corporations. Carrier networks based on frame relay provide communications at up to 1. 544 Mbps (in the United States), shared backbone bandwidth on demand, and multiple user sessions over a single access line. The throughput is higher than that available for traditional packet switching, making the service attractive for applications that involve LAN-based communication, including image transfer, but not voice or video. In a private frame relay network, the switches and trunks are put in place (typically) by the corporate communications department of the company in question. In either case, the service can provide permanent virtual connections (PVCs) and now also switched virtual connections (SVCs).

SMDS is a high-performance, public, connectionless service developed by Bellcore (Bell Communications

Research) in the late 1980s. Access to the network is based on a subset of the Institute of Electrical and Electronics Engineers (IEEE) 802.6 MAN standards. From an interface point of view, access to SMDS is established through a subscriber network interface (SNI), which may provide either a DS3 access path (with multiple access classes) or a DS1 access path. For a DS3 access path, single or multiple customer premise equipment (CPE) access arrangements are available.

The access protocol, SMDS interface protocol (SIP), is based on distributed queue dual bus (DQDB) connectionless protocol. This protocol operates at the media access control (MAC) level of the data link layer (layer 2) of the Open System Interconnection Reference Model (OSIRM). As a result, SMDS can be supported by various higher-layer protocols, such as transmission control protocol/internet protocol (TCP/IP). SMDS supports five service-access classes. One of these access speeds can be supported by a DS1 access line, while the other speeds (4 Mbps, 10 Mbps, 16 Mbps, 25 Mbps, 34 Mbps) can be obtained by using a portion of a DS3 line. SMDS also operates at 64 Kbps. SMDS supports data-oriented (not video) distance learning application, such as groupware and internet, and is applicable to corporate distance learning applications, such as corporate training.

ATM refers to a high-bandwidth, low-delay switching and multiplexing technology now becoming available for both public and private networks. It supports voice, video, and data. While ATM in the strict sense is simply a (data link layer) protocol, the more encompassing ATM principles and ATM-based platforms form the foundation for a variety of high-speed digital communication services aimed at corporate users for high-speed data, LAN interconnection, imaging, video, and multimedia applications. Cell relay service (CRS) is one of the key services enabled by ATM. CRS can be utilised for networks that use completely private communication facilities, completely public communication facilities, or that are hybrid. A variety of vendors now have ATM products on the market.

A number of carriers (e.g., Teleport Communications Group) either already provide services or are poised to do so in the immediate future. ATM supports both switched (SVC) and non-switched (PVC) connections. ATM supports services requiring both circuit-mode and packet-mode information-transfer capabilities. CRS supports both data-oriented distance learning applications such as groupware and internet, as well as video-oriented distance learning applications. ATM employs SONET facilities as the transport medium. These fibre-based facilities support data rates that are multiples of 155 Mbps.

Solutions supporting local communities

Networking solutions currently offered by the local telephone companies, such as dialup and ISDN basic rate interface (BRI). They also encompass solutions offered by cable TV companies. In addition to these existing solutions, a number of broadband solutions are being introduced or tested by the local exchange carriers (LECs), including video dialtone (VDT) solutions.

Asymmetric digital subscriber line (ADSL) is an emerging high-performance copper-based technology. It is intended to provide more bandwidth out of the existing loop apparatus (i.e., the copper-based plant). ADSL is currently being evaluated or trailed by some RBOCs. Effectively, it is a repeaterless DS1 technology, but the bandwidth is asymmetric. In the forward channel (network-to-user), ADSL supports DS1 rates (1.544 Mbps) at 18 kft from the central office (CO) and T2 rates (6 Mbps) at 12 kft from the CO. It also has one bidirectional 160-Kbps ISDN basic rate channel containing two "B" channels, a "D" channel, and associated operations channels. Hence, the reverse channel (user-to-network) is much more limited.

The key targets of ADSL-based services are residential customers, local community colleges, and K-12 schools. Consequently, ADSL is applicable to the distance learning access applications that involve those local communities. ADSL can be applied to both video- and data-oriented distance learning applications, particularly internet access, given its capabilities. It also can be used to deliver VDT services. The future of ADSL may be limited, however, because many carriers prefer to channel the nontrivial perloop investment required to provide it toward the construction of a broadband fiber-based access loop. The narrowband and wideband solutions described here provide substitutes to each other, each with a set of strengths and weaknesses. Some of these solutions can also complement each other, providing users with hybrid solutions.

A discussion of ADSL necessitates a discussion of hybrid fibre/coax (HFC), although ADSL technology is being pursued (if at all) by the traditional LECs, while HFC is being pursued by the cable TV companies as well as by the LECs. At this time, most of the cable TV industry is working on upgrading the traditional, all-coax network to fibre/coax hybrid systems. In many cable TV networks today, fibre is being used at least in the trunk portions of the network; as time goes by, fibre will make even more inroads.

Ultimately there is a desire—and a need—to provide fibre connectivity all the way to a residence or an institution. This, however, is still fairly expensive. The telephone carriers, namely, LECs and alternate access providers (AAPs), have brought fibre to customers that are "large enough" but not to smaller customers, residences, and educational institutions. By contrast, the cable TV companies have not yet brought fibre connectivity directly to their end customers. However, they have embarked on efforts to use fibre as far as the "node" in the neighbourhood, from which traditional coaxial runs emanate. Those systems are known as HFC. Improved HFC networks support more bandwidth (currently up to 1 GHz; greater amounts in the future), use compressed digital video in both the server and the transmission plant, and even employ ATM. One of the more sophisticated such networks to emerge is Time Warner Cable's Full Service Network. This network, under trial at press time, supports traditional cable TV distribution services, video on demand with instant access, interactive TV services, interactive games, access to long distance telephony, video telephony services, and personal communication services (PCS).

A representative, reasonably sophisticated HFC cable TV network of today would support 450 MHz of bandwidth; it would have fibre spans no longer than 10 miles, although that can be extended farther with hub sites and regeneration; it would have approximately five total miles of coaxial cable per node, with a maximum of three amplifiers in cascade; each node would serve about 500 homes; and it would typically use the band 3-33 MHz for the upstream channel to support some level of interactivity.

Compared with the all-digital and hybrid analog/digital HFC systems, the all-analog HFC system provides the lowest per-subscriber cost, especially for low "take-rates" (25-40%). Such a system, however, is the least sophisticated system in terms of supported services and, hence, in terms of revenue potential for carriers (typically these systems support only broadcast video). Also, the cost per subscriber increases considerably when the providers want to deliver a number of channels that necessitates two coaxial cables into each home. In the future it is likely that digitally modulated fibre (SONET-based) will be employed more extensively, particularly for fiber-to-the-home (FTTH) and fiber-to-the-curb (FTTC) architectures, especially to support ATM.

Dialup access is based on traditional analog telephony methods. This so-called plain old telephone service (POTS) approach involves the use of modems to connect the user PC (owned by the user or provided by the corporation) to the remote server or host; it utilises the analog public telephone network. Circuit switching implies that the communications channel is not dedicated 24 hours per day but must be brought on line when needed (via a process called call setup) and then taken down when no longer needed.

Traditional modems have operated at speeds up to 19.2 Kbps and are now up to 28,800 Kbps; however, until recently, 9.6 Kbps has been more common. That implies that the throughput across this type of link is fairly small; consequently, only a small number of users or short inquiry/response-like transactions can be supported. Since the link between the two points is not available on a dedicated basis, the user needs to dial up the information provider, as needed. File transfer is limited to relatively small files.

Video dial tone (VDT) is an emerging information exchange and exchange access service that is being offered by LECs to support video information users (VIUs), including distance learning receivers and providers, in accessing video applications, as well as multimedia applications, offered by video information providers (VIPs). Each VIU household subscribing to a VDT service may be able to establish either a single session or multiple sessions, depending on implementation. Each VDT session includes three types of information flows: One-way video distribution, Associated two-way data flows between VIPs and VIUs, if required and Signalling.

Because of the required bandwidth, the implementation of VDT networks can be based on ATM over SONET. ATM can provide the switching function, while SONET provides the transmission functions. Through the ATM technology, only the channels of specific interest are switched into the user's access facilities. The backbone portion (from the serving CO to the VIP) could employ an OC-24 (1.2 Gbps) transmission system or an OC-48 (2.4 Gbps) transmission system. Six access technologies can support VDT services and are either considered or implemented by at least one RBOC. These solutions are: ADSL, HFC fibre to the node (FTTN), FTTC, fibre to the building (FTTB), and FTTH or fibre to the site.

Cable TV companies provide local communities with an increasing number of services. These services include access to educational TV programs, data over cable services, interactive TV services, and telephony. In addition to improved video delivery using HFC technology, data communication over the same cable is also being advanced. The key components of data on cable systems include:

— A cable modem, with PC adapter card. This modem uses subscriber data to modulate a 6-MHz carrier upstream to obtain bandwidth in the range of 1-10 Mbps. Currently, this type of modem tends to use proprietary encoding methods. It also receives and demodulates a 6 MHz carrier downstream.

— A frequency translator in the headend that takes upstream transmissions from customers and converts the transmission signal to a downstream broadcast channel. Multiple translators can support multiple independent LANs.

- A bridge or router in the headend that provides access to WANs.

ISDN provides end-to-end digital connectivity with access to voice and data (both circuit switched and packet) services over the same digital transmission and switching facilities. It provides a range of services using a limited set of connection types. ISDN supports a small number of physical user-network interfaces. The more well known of these interfaces is 2B+D interface, which provides two switched 64-Kbps channels, plus a 16-Kbps packet/signalling channel (144 Kbps total).

Other less-known ISDN interfaces include 1B+D, which are currently trailed by some LECs, and NB+D, where N is greater than 2 but less than 23. Although many users now employ faster modems, operating at 14.4 Kbps, 19.2 Kbps, 38.4 Kbps with compression, and even 57.6 Kbps with even more compression, ISDN offers a more "comfortable" 64 Kbps, 128 Kbps, or even 384 Kbps throughput, affording adequate flexibility to the user. Some see a combination of ISDN and FRS as a viable way to bring in remote users and connect them to the information provider's network. ISDN can support data-oriented as well as video/audio-oriented distance learning applications.

Less developed countries and rural environments with dispersed populations or rugged terrain have found satellite systems to be the practical way to support their telecommunications needs. Geosynchronous satellites, which maintain a fixed position relative to the ground, have been used for commercial applications for over 25 years. They have seen increased deployment, starting in the early 1980s, as relatively small earth stations became available.

Typical applications include video broadcast, voice telephony, and wideband data transmission implemented on a point-to-point or a point-to-multipoint basis. The major potential for satellites is now for private network services on a point-to-point or full-mesh basis. A satellite is a communication device that receives signals from a ground station, amplifies them, and broadcasts them to all earth stations capable of viewing the satellite and receiving its transmissions.

The satellite is an active radio relay, much like the radio relays used in terrestrial microwave communications: A satellite transmission begins at the earth station, traverses the satellite, and ends at one or more earth stations. A satellite communication link involves three elements: the space segment, the transmission path element, and the ground segment. The space segment consists of the satellite itself, along with the supporting telemetry to keep the Satellite in orbit.

The transmission path is the radio spectrum used for communicating to and from the satellite; issues such as frequency, signal interference, modulation schemes, and protocols used to ensure proper transmission and reception (multiplexing and multiple access schemes that allow fair and efficient access to satellite channels) affect this portion of the overall system. The ground segment includes the earth stations; issues such as placement, construction, and types of antennas used for different applications are part of the design of a satellite-based communication system. Many distance learning systems currently employ satellites to achieve one-to-many transmission of the video programme; the return audio path is generally supported over a dialup telephone link from the remote sites.

Very small aperture terminals (VSATs) are a satellite transmission technology that was introduced in early 1980s. VSATs integrate transmission and switching functions to support on-demand links for, point-to-point, point-to-multipoint applications. It is (generally) an asymmetric technology with a shared inband channel and (generally) a common outbound channel. VSAT earth stations include: an antenna of small diameter (e.g., 1m); a radio-frequency power unit that provides 1-5W of power to support communications at bandwidth up to 1.5 Mbps over the transmission band (typically the Ku band at 12/14 GHz); and a master earth station (MES), linked via satellite to

VSAT earth stations, which performs routing and management functions. The MES can be either operated by a large company or shared by small companies subscribing to a facility operated by a service provider.

NATIONAL INFORMATION INFRASTRUCTURE

The networking solutions needed by education providers and receivers are not uniformly available, nor are they uniformly affordable. The affordability and ubiquity of these services cannot be improved without the creation of a national information infrastructure (NII). This is a topic of intense debate and interest to the federal government as well as to state governments, universities, and network services providers. A number of initiatives are currently being carried out by these players. The federal government and the state governments play vital indirect roles in speeding the process of creating an NII as well as in education reform. These roles include financial role, regulatory role, user role and educator role.

The financial role of the federal and state governments refers to their efforts to finance and build statewide networks. The regulatory role of the state governments refers to the efforts of the public utility commissions of the individual states as well as to those of the FCC to remove barriers to competition and to provide incentives to the expansion of the distance learning programmes. The telecommunications reform legislation of 1996 opens the telecommunications marketplace to greater competition, which, many expect, will increase the quality of and reduce the cost of service.

The state and federal governments are large consumers of information technology. The state and federal governments play an important role as advocates of distance learning. They also play a direct role in resolving education problems.

To play these roles effectively, the federal and state governments need to introduce regulatory and legislative reforms (workfare reform, education reform, and immigration reform). They can also provide financial incentives to education providers and receivers. In addition, they can get directly involved in the distance learning industry by introducing new distance learning technologies. These technologies can address many problems such as the education of welfare recipients and the structurally unemployed.

Carriers and telephone companies play an active role in building the NII and in delivering a number of services that ride on the NII. The telephone companies view the NII as a tool to face these challenges and to differentiate themselves from their existing and emerging competitors.

Two closely related groups, the cable TV companies and the AAPs, are the main competitors of the traditional telephone companies in the creation of the NII and in the delivery of distance learning services. Their roles include building joint regional cable TV-AAP networks to provide an increasing number of services, including data over coaxial cable and access to educational TV programming. AAPs are now receiving equal status to the LECs in a number of states.

While many AAPs are allied with the cable TV companies, a few companies are not. These independent AAPs are building MANs and offering services, primarily to business users, that include private-line services, LAN interconnection services, and, increasingly, switched data services. Most AAPs are evolving along two parallel tracks: the traditional AAP—a fibre network providing private lines and special access in a downtown central business district—is becoming an endangered species in the view of some observers.

AAPs are becoming either national AAPs or what have been called competitive LECs (CompLECs, also known as CLECs). National AAPs will continue to do what AAPs have done over the years: serve telecommunications-dependent businesses, which need the operational and strategic security that is accrued from having a diverse source of supply for critical local telecommunications services. But it is no longer enough for an AAP to be a diverse source only for so-called "dumb" services such as private lines and special access.

Quality in Distance Education

Distance education expanded with an overwhelming momentum, both in its use and misuse, as teacher training and science-based programmes began to multiply rapidly on the one hand and professional-vocational and awareness-extension programmes expanded on the other. The debate became broadbased as the validity of using conventional norms and notions of effectiveness as a measure for the effectiveness of distance education came to be questioned. The attention of those concerned shifted slowly but steadily from mere perception of quality need to reality. Hardly anything in concrete terms could be characterised as a quality assurance mechanism in the Indian educational system, be it conventional education or distance education.

The arrival of distance education on the scene, first as correspondence provision and later as an open and distance university-based offering provided an alternative pathway to pursue higher education not only for basic degree courses but also for professional courses in management, teacher education etc. By this time the conventional university system had consolidated its structure and stabilised its approach to what was called "good quality" higher education through the policies and action of University Grants Commission. These revolved around five broad thrusts:

1) Laying down minimum and essential qualifications and experience for various academic and other staff in college and universities.
2) Developing norms and standards for academic provisions through model curricula, teaching plans and examination systems.
3) Fixing of minimum necessary infrastructure in terms of land, buildings, classrooms, labs, library, etc.
4) Providing funds and grants for developing new thrust areas such as computers, bio-technology, etc.
5) Establishing new postgraduate departments and centres of excellence as well as providing audio visual support through "countrywide classroom" broadcasts.

None of the above initiatives and provisions could be "transferred" for application to the new and upcoming distance education stream. Therefore, without any statutory constraints and infrastructure restrictions on the number of students to be admitted, the distance education wings of the conventional universities came to be looked upon as cash cows. "Partly because distance education institutions launched courses without any reasonable understanding of the distance education system, very often without sufficiently preparing for effective distance education transactions." The initial reaction of distance educators in India manifested in their building a defence mechanism for distance education systems and not for the conventional system.

The perceived effectiveness of conventional education was used as a standard measure for the effectiveness of conventional education. The University Grants Commission has realised as well that they play a recommendatory and funding role and that, if an institution can mobilise funds independently, it will not bother about UGC recommendations and guidelines. It was time the issue of quality in education was addressed afresh.

Movement in education

Hence the ISO 9000 culture requiring not only profession of quality of products but a demonstrable proof of the quality culture in the operations from the inspection of incoming raw materials range of successive manufacturing operation, internal quality assurance mechanism at all intermediate stages as well as predespatch testing, were required to be documented and demonstrated to the outside trained and certified inspectors and lead assessors. This, in turn, had its parallel effect on the other sectors including education which was rated as "service" which well defined the objective of taking in a raw students as an input and to transform him/her into a graduate fit for assisting in the wealth creation activities of the socio-economic system.

The almost simultaneous establishment of the National Assessment and Accreditation Council (NAAC) by UGC and the National Board of Accreditation (NBA) by AICTE for the technical education sector bear out these common concerns and felt needs. Both these bodies have evolved specific criteria and techniques assessment of the relevant quality parameters. The NBA had, in addition, gone in for a system of grading of the programmes of institution based on the score it achieved on a designated scale. This was considered essential as the variation in quality of existing programmes and institution was considerably large.

Quality assurance in distance education

The distance education system in this country has eight open universities and 58 distance (mainly correspondence) institutes/directorates attached to the conventional universities. The Indira Gandhi National Open University is the flagship of this distance education system and under its Act, the Distance Education Council (DEC) was established to promote, coordinate and maintain standards.

Quality assurance of IGNOU

IGNOU has already established itself as a leader amongst distance education institutes. At IGNOU, quality assurance activities focus on all the major and critical processes in distance education quite similar to those at the open universities, but the measures taken to achieve the desired quality differ considerably.

Existing built-in quality assurance mechanisms are as follows:

a) planning the course or programme;
b) developing the course or programme;
c) producing the learning materials;
d) implementing the course or programme;
e) reviewing the courses and follow up activities; and
f) developing human resources.

Planning the course or programme

Each school or division is expected to present a perspective plan covering a period of about five years. This perspective plan must be approved by the coordination committee and subsequently, after incorporating the modifications the committee suggests, the perspective plan must be approved by the planning board. Within the approved perspective plan, the school or division is expected to prepare a project concept pertaining to each course or programme that they want to launch.

Planning academic programmes

The faculty may also initiate proposals. These proposals initiated by either the Vice-Chancellor or the faculty are placed before the coordination committee, which is a non-statutory advisory body made up of all senior functionaries like the deans of the various faculties and directors of the various service units. After the coordination committee approve the proposal, the faculty or department prepares a detailed proposal for the consideration of the academic senate, the highest statutory academic authority of the university that is empowered to approve academic programmes.

Developing curricula and learning materials

After a programme is finally approved, an expert committee made up of the internal faculty members and external subject experts is constituted to prepare the curriculum. The committee may meet once or twice for this purpose, and the curriculum thus designed is sent for approval to the academic senate. The approved curriculum and syllabus are passed on to the course team, which consists of subject experts (both from the university and from outside institutions) and an audio-visual producer, who is designated for the programme or course. The team is headed by a subject expert, who is designated the editor and is responsible for content editing and quality or presentation. Language is edited by language experts.

The course team also identifies the audiovisual components of the materials, which are developed by the audio-visual centre with the help of the producer and subject experts. Depending on the nature of the course or programme, field practitioners are also associated with the development of learning materials as course writers, editors, or audio-visual programme developers. The audio-visual materials are previewed by the internal faculty before they are duplicated for use by students.

The quality assurance mechanisms that function at this stage include:

a) editing learning materials for different purposes (content, format and language);
b) coordinating with the producer of audio-visual materials and previewing the audio-visual materials before they are duplicated; and
c) orienting the course writers to make them familiar with the requirements of quality.

The internal faculty read the final proofs to ensure error-free publications. Similarly, the audio-visual unit is responsible for producing the audio-visual tapes in accordance with an audio-visual manual prepared by the university. The mechanisms to ensure the quality of paper, card and blank tapes are the advisory technical committees, which set the minimum standards for the quality of the materials the university is to use. The general quality of printing is assured by penalty clauses in the agreements with the printers. Duplicated copies of audio and video tapes are also randomly checked.

Implementing the course or programme

A course or programme is implemented through many processes: the despatch of materials; counselling, tutoring, and practical work at study centres; assignment handling; query handling; feedback; and evaluation. The quality of these processes is assured by ensuring the prerequisites which support them as follows:

a) despatch of materials: availability of materials in the warehouse, availability of schedules, adherence to schedules, quality of packing;
b) counselling, tutoring, and practical work; availability of schedules, adherence to schedules, punctuality, regularity, availability of facilities, attendance of learners, quality of learners, quality of counselling or tutoring, practical work and interaction, use of audiovisual materials, learner satisfaction;

c) assignment handling especially ensuring: availability of schedules, adherence to schedules, short turn-around time, quality of assessment;

d) query handling reached to: pre-admission services, on-course services, and post-course services;

e) Feedback on quality of print materials, quality of audio-visual materials, quality of counselling, tutoring, and practical work, quality of assignments, quality of support services in general; and

f) Evaluation availability of schedules, adherence to schedules, conduct of examinations, turn-around time in the case of assessment, handling of appeals made by the students and discipline issues, results (time taken for declaration) and their accuracy, regular and timely certification.

Regional centres are expected to monitor study centres for the quality of their management, tutoring, and counselling, and their general function and facilities, while study centres provide feedback on their infrastructure, the functioning of tutors and counselling, and learner behaviour.

Reviewing the courses and follow-up activities

Course review activities are mainly on the feedback made available to regional centres and, in turn, to headquarters. Along with the project report at the start of the course, a review document is prepared, which outlines a timetable for receiving feedback as well as the various areas under which feedback is to be received. Feedback informs decisions about whether the course should continue (entailing preparation of new assignments and programme guides for every year), be modified (entailing maintenance of courses through supplements and minor revisions), expanded (entailing restructuring of courses and also increasing the content by means of revisions) or withdrawn.

QUALITY ASSURANCE IN LIBRARY EDUCATION

The role of library and information professional have totally been changed in the present day society with the application of information and communication technologies. They are no more library professionals, rather they are called information professionals. As on date there are 108 universities/ colleges and institutions in India offering Library and Information Science programmes. Of these 108, there are 27 Open Universities and Correspondence Course Institutes (CCIs) offering Library and Information Science programmes through distance/correspondence mode. The objectives of offering Library and Information Science (LIS) programmes through correspondence/distance mode are mainly due to the fact that it:

- transcends geographical/physical barriers of a learner,
- provides access to higher educational opportunities which is not possible through the conventional mode,
- allows more flexibility in completing the programme at the learner's pace of study,
- helps in career advancement schemes of the working employees by acquiring a professional qualification,
- enables younger talented group to complete the programme from the job point of view,
- improves capabilities in understanding organisation and management of libraries/information centres and documentation centres; and
- caters to manpower requirement of different types of libraries/information and documentation centres.

The Library and Information Science (LIS) curriculum lays emphasis on the fundamentals of different types of libraries and its management, bibliography and reference service, classification and cataloguing, collection development, information and documentation and some theoretical background on computer technology. But in the present day context the entire LIS curriculum need to be technology oriented.

The practical skills of the distance learners should be improved so as to handle these libraries/information centres/ documentation centres. Much emphasis is to be given on collecting, organising, processing and disseminating information with the help of modern computer and communication technologies. Application of information technologies in the libraries and information centres shall enable the learners to develop his or her computer skills for its effective organisation. These include:

a) library automation or computerisation of inhouse operations,

b) database design and searching using readily available software packages,

c) searching of CD-ROM bibliographic databases,

d) preparation of online search strategies and searches of databases,

e) multimedia application in libraries, and

f) organising information resources available on Internet etc.

All these will help those who are already employed in different libraries and information centres for their professional development and betterment of employment opportunities.

Identification of centre

Institutions interested in activating these programmes should be named as Partner Institution/Programme Specific Centre (PSC) or work centre. These host institutions should have all facilities such as classroom, library, computer facility, resource persons, audio-video and a good collection on library and information science including the reference material. All these facilities will enhance the quality of delivery of programmes effectively to the distance learners.

Student support service

Student Support Services need to be strengthened such as timely delivery of study material, counselling, library and computer facility, watching audio video programmes, teleconferencing, national telecast programmes, evaluation of assignments, etc. Various problems of students, both academic and administrative in nature, should immediately be attended so that a learner is motivated to complete his or her programme in time.

Training to the trainers

A special training need to be conducted on how to prepare the trainers for counselling and Personal Contact Programmes (PCP) as well as evaluating the assignments of the distance learners. Strong motivation on the part of the distance learners make them successful in completing the programme in which counsellors are the mediators between the university and the learners.

Feedback is another technique of quality assurance for improving, updating and making the programme more learner-oriented. All these programme-related components need to be evaluated by the students, counsellors and experts in terms of curriculum, programme delivery, maintenance, student support services, examination and evaluation, etc. Therefore, periodic feedback programmes, in-depth study and analysis, and tracer studies need to be conducted so as to improve and assure the quality of the programmes on offer.

DEC initiatives

The Distance Education Council has taken a number of initiatives under quality assurance schemes to develop norms and standards for various professional programmes offered through distance mode. Library and Information Science is one of them in which the DEC constituted a committee consisting of national experts in the field of library and information science to develop norms/standards for BLIS and MLIS through distance mode.

These norms pertain to course curriculum, annual intake, eligibility, counselling, student support services, faculty requirement and other infrastructural facilities that are very much essential to offer BLIS and MLIS programmes through distance mode. Quality can only be assured if these norms are properly followed by all open universities and correspondence course institutes.

Impact of information society

The advent of information and communication technologies and its application in library and information centres has changed the role of library professionals to information professionals. Now library and information professional need to be trained in the areas of Library Automation, CD-ROM, Online, Online Public Access Catalogue, Multimedia, E-mail, internet etc. The impact of such an information society has compelled the LIS professionals to redesign the LIS programmes so has to provide effective and efficient information services in a rapidly changing technological age.

Developed countries particularly in LIS education through distance learning shall help a lot to the planners, designers and academics associated with these programmes how to make it more innovative, interactive and cost effective in India. Universities in USA, UK, South Africa, etc., have made it more technology-oriented and much has to be done for these programmes in India, particularly at the designing and implementation stages. They are going to be the innovative problem solvers and effective information managers possessing a broad range of capabilities to meet the high demand of libraries and information centres in business and industries.

TECHNOLOGIES IN DISTANCE EDUCATION

Technology can help distribute education from the world's best sources to all the people irrespective of age, sex, creed, religion, socio-economic status, who are in need of education wherever located, thus crossing all geographical and social barriers. New technologies, namely satellite communication, fibre optic cable and computers have dramatically enhanced educational capabilities.

By providing communication links, telecommunications can overcome distance barriers that hamper development. Thus through the use of new communication technologies, access to good educational programmes can be greatly extended to large audiences in rural and remote areas with tremendous flexibility in subject matter content and in locations served. Corollary to these technological expansions, the area of education which is considered to be fastest growing today is that of distance education.

Distance education, based on the use of modern communications and multimedia materials, has proved to be the major new movement in human resource development in the current decade. The ability to cope with rapid changes in the higher education system will become the primary measure of success, of both micro and macro levels, as we approach the 21st century. Change is occurring faster everyday. Many societies have shifted from industrial era to information era, and others are fast moving in that direction. The volume of information that becomes available, doubles every four to five years.

Stating it another way, the total of all human knowledge that was available to an undergraduate in 1997 will be less than one per cent of what will be available to his/her counterpart in the year 2050.

Teachers have to become experts in helping learners navigate through this sea of information rather than pretending to be effective transformers of that information into knowledge. Students must be trained to bring about that information. Those who survive this information explosion will be able to deal with it effectively and even more importantly, acquire knowledge. These changes have a major impact on education and training.

In fact, education and training are also undergoing a major change. The focus has shifted to learning rather than teaching. Some of the major changes are:

i) From institutional-based learning to far learning organisations with just in time knowledged provisions;

ii) From fixed curricula to personalised curricula;

iii) From front ended education to lifelong education;

iv) From teaching to learning.

Education is going to be number one amongst the great world industries, within which will flourish an educational machine technology that will provide tools such as the individually selected and articulated two-way TV and an inter-continentally networked documentary call up system operative on any home two-way set.

Bates has outlined the developments in communication and information technologies with implications for learning which are the following:

- — Integration of television, telecommunication and computers, through digitisation and compression techniques;
- — Reduced costs, and more flexible user applications of telecommunications, through developments such as ISDN/fibre optics/cellular radios;
- — Miniaturisation (tiny cameras, microphones, small high resolution display screens);
- — Increased portability, through use of radio communication and miniaturisation;
- — Increased processing power, through new microchip development and advanced software techniques;
- — More powerful and user-friendly commands and software tools, making it much easier for users to create and communicate their own materials.

Due to these developments the learner will be increasingly free to choose what and when he/she can learn from what source.

In India distance education has emerged as a formidable system of higher education. There are at present eight open universities in India and about 50 distance education divisions attached to conventional universities. There is also a National Open School in the country. While one must admit that the conventional education system has played an important role in expanding education, particularly in the urban areas, over the last 50 years or so, one must accept its limitations as a means of mass education and especially quality education in the rural areas.

The costs of infrastructure necessary for the traditional type of education have gone up tremendously, but most of the state governments are suffering from resource crunch. There are competing demands for public resources from various other non-educational sectors. On the other hand, the population of the country is growing steadily, outstripping the growth of schooling facilities, with the exception of some areas. This fact coupled with the high dropout ratio has resulted in net additions of illiterate people from decade to decade.

The conventional system of education has proved inadequate in the face of rapidly increasing population.

The emergence of the information technology including the satellite-based telecommunication system has generated a potential of a sea-change in the education system all over the world. Print, radio, television, audio-video cassettes, tape-recorders, overhead/slide projectors, filmstrips, etc., which permit only one-way communication have become old educational-technologies and have lost novelty in the developed world.

The last one decade has seen emergence of a series of new, electronic-based innovations in the field of higher education, which permit vision, sound, data with inter-activity. Information highways are high speed data networks used to transport information and link people who want to be connected with others. Teletext and Video-text are the two new information age services that will soon be widespread among home and business users. Teletext is a one-way service in which pages of information from a central database are broadcast on a regular television signal. Video-text is a more sophisticated two-way service using telephone lines. E-mail, tele-conferencing (audio and video) and computer conferencing are common activities on the internet and other electronic networks. The words information highway reflect speed, volume, powers, and efficiency.

With the information highways becoming a reality in many countries, Conferencing Technologies (CT) have come to be used in a large way in collaborative distance and open learning. The success of CTs will depend on the extent to which learning tasks, such as attentiveness, idea generation, concept elaboration, feedback, etc., are fulfilled. The CTs reduce the teachers' teaching functions without reducing the academic rigour. Since generally the adults are the participants of CTs, a collaborative type of learning is necessary. When integrated into the whole learning context, CTs offer sufficient flexibility to the learners and the educators.

Thus, a virtual classroom can be created in which the class is taught using the satellite, microwave or cable linkages between them. The electronically linking of students and teachers at various locations by cable, microwave or satellite has made it possible to create this face-to-face teaching at a distance. There is no doubt that an extensive emergence of electronic-based technology in the field of education is in the offing. However, one must not forget limitations in its use, especially in the developing countries.

The advocates of the modern technologies in education presuppose that the learners have access to a wide range of high specification information and communication technologies; that these technologies can be used at time and in circumstances that are convenient for learners and optimal for effective study; and the learners have sufficient familiarity or experience of using them. Unfortunately all these presumptions are far from true so far as learners in developing countries are concerned.

Though there may be television in the house, there is certainly a claim of all members of the family for using TV for entertainment purposes. Not many students have access to VCRs because of the costs. Even those who have VCRs may not always be able to use them in view of the competing demand for TV time by others. PC and modems are absent in most of the learner houses in the developing countries. Flexibility is also a limiting factor. The TV, the VCR or the computers cannot be used away from home.

The most modern multimedia computers are conspicuous by their absence even in the higher educational institutions, not to talk of private homes. Multiplicity of languages used in the same country, as in India, also poses severe problems in reaching distance education to different parts through the broadcasting/networking systems. Thus, there are severe limitations in the use of high specification information and communication technology in the developing countries. It may take two to three decades to reduce these limitations to an insignificant level.

It will be difficult to protect national, state or provincial boundaries from distance education. Governments will have to deal with the question, sooner or later, whether they would like to be net exporters or net importers of education. The answer of course is quality.

The distance teaching institutions, in particular, will have to demonstrate superior quality of education that will override the public's preconceptions of the status of better-known, more conventional institutions as they enter into the distance teaching world via the internet. There is also the question of access.

The high specification information and communication technology can be accessed only by the rich and the very rich in the developing countries who can afford to have a number of TVs, modems, computers and can afford to pay for long distance call charges, etc. separately for entertainment and education purposes. The proportion of such learners is microscopically small. Since they belong to the elitist society they would, anyway, have been well educated in the conventional system of education. Electronic-based technologies will dominate the education scenario in the developed countries.

The 21st century will give rise to electronic educational institutions which will provide information on education and training needs and opportunities; quality control; accreditation; coherent curricula and other concomitant services. Many of the instructors or tutors may not belong to the educational institutions but will be independent contractors. Nor would it be necessary for learners to be registered with an educational institution. The educational institutions may only collect and deliver payments for fees and royalties to the owners of the software or the telecom companies.

Unless the less developed countries are able to create an appropriate technological infrastructure to support the kind of learning needed in the 21st century, they would be left far behind. Building up of information highways are the *sine quo non* of the modern system. The need of the 21st century will be to exploit the information highway to the fullest possible extent. Economic development will depend to a large extent on creating and optimally using the technological infrastructure.

DISTANCE LEARNING CHALLENGES

Interactive Distance Learning (IDL) is one the technological tools that can contribute to the solution of educational problems and challenges which universities are facing.

LINKS AND APPLICATIONS

The IDL links enable universities to establish closer ties with their corporate and government clients by enabling them to rapidly share information among members of the R&D community, speeding up the process of R&D and the development of new products and services. The IDL can also resolve some of the financial problems facing universities by providing them with economies of scale.

Through IDL, universities can create a greater number of remote classes. This creates education providers with the opportunity to generate more revenues per teacher or to reduce the tuition per student. A university can differentiate itself from other universities by being at the leading edge of IDL technology.

However, universities cannot hope to maximise the benefits of automation without attacking those problems through specific IDL applications, identifying the communication applications that are solving the problems, and implementing innovative solutions that can address the problems.

Various university buildings need to establish intra-university and interuniversity communications links with university branches, other colleges, dormitories, and external sources of information.

The following IDL applications drive universities needs for the establishment of these links:

Collaborative learning

Collaboration is important to university students so they can share and analyse scientific data, have extended discussions with other peers, and work together to produce papers and journals. Traditionally the sharing of information relied on text-based e-mail and on face-to-face meetings. Increasingly, university students and researchers are seeking computer graphics and animation-generation systems with text.

Access to databases

Students, instructors, and researchers need to have access to a large number of databases. The nature and locations of the databases are shaped by the type of research that an individual is performing. These databases have two common characteristics: (a) They are accepted standards in their respective research communities, and (b) they are large. The large size of the databases and the impracticality of duplicating them in every research lab across the nation necessitate the availability of broad-band networks to researchers to maximise the speed of scientific research and development.

Access to supercomputers

University needs for access to supercomputers are shaped by the needs of the various groups of researchers operating in an university environment. For collaborative learning to be effective, educational experts believe that schools have to change in the following ways:

- i) Effective collaboration becomes more useful as the number of teachers and students participating in a specific collaborative effort decrease.
- ii) Effective collaboration among students and teachers belonging to the same team requires more effective scheduling for groupwork.

Access to libraries

In preparation for their assignments, students need to access digital libraries as a substitute for physical access to libraries. This will provide them with access to a wider range of information resources that may be available in their university library. They need connectivity to these libraries to access electronic books, periodicals, and other publications.

Collaborative learning and research

Collaborative learning encompasses the establishment of communication links among students, teachers, and researchers. Collaboration is not limited to the formal hours of schools, nor is it limited to a university campus. Students can benefit from getting in touch with their professors after class hours for several reasons: (a) to inquire about a specific project or report assignment, (b) to deliver the work to their instructors electronically, and (c) to receive comments back from their professors.

Remote learning

Universities need to create remote classes to support the educational needs of their smaller branches as well as those of smaller universities. Remote classes provide universities with the following benefits: (a) they increase the number of teachers per student, and (b) they reduce the costs associated with building new classes and expanding campuses. To create a successful remote education solution, universities need to consider the following needs of students:

i) *Interactivity*: This is a key element of any successful IDL programme. The more the IDL solution selected by the university involves interactivity, the more it will be successful in getting students involved, enabling them ask questions and be stimulated while taking the course.

ii) *Instructional feedback*: This extends beyond the provision of grades by instructors to students on specific assignments, and it encompasses providing answers to questions after university hours.

iii) *Elimination of time constraints*: Through IDL solutions, students and instructors can, to some extent, free themselves from the constraints of time. This means that an effective IDL solution should enable students to maximise the time of their interactions beyond classroom hours.

iv) *Motivation*: An effective IDL solution should enable students to have fun as they interact with other students and teachers.

Besides the needs of students, instructors, and researchers, the needs of the telecom/datacom managers, are also responsible for the evaluation, selection, design, implementation, and operation of IDL solutions. In selecting the IDL applications, telecom/datacom managers of universities need to take into account a number of factors, some of which are specific to the university telecom/datacom environment.

The telecom/datacom infrastructure of a university is shaped by several factors: (a) whether the university or college is public or private, (b) the founder of the university, (c) the size of the university, (d) the specialisation of the university, and (e) the physical location of the university. The telecom/datacom environments of large universities resemble those of large industrial parks.

The university telecom/datacom infrastructure may include some or all of the following elements:

- *A voice networking environment*: This is supported by a PBX or centrex and extended over a metropolitan area through either private lines or a public switched network system.
- *Legacy systems*: This include older minicomputers, administrative mainframes, and even Ethernets and token rings.
- *A client/server environment*: Clients and servers, which may be spread around the campus and interconnected across LANs, such as Ethernet, Token ring, and FDDI.
- *Satellite-based networks:* It used by universities both to originate and to receive IDL programming.

While universities may have similar infrastructures as those built by corporations, they differ in one major way: universities are innovators and are willing to explore new technologies, even if those technologies are not well proven. In contrast, corporations would consider only a proven technology before committing their resources to the adoption of a technology.

- *Geographic coverage*: Telecom/datacom managers of universities seek application solutions that support the geographic range of universities.

— *Ease of use and administration*: Telecom/datacom managers value application solutions that are easy to administer and to use by IDL receivers and providers.

— *Intra-enterprise versus interenterprise communications*: The appropriateness of the application solution to a university may depend on the extent of the needs of telecom/datacom managers for inter-university versus intrauniversity communications.

— *Inter-operability and compatibility*: Telecom/datacom managers are seeking solutions that are not proprietary but based on open standards. This would enable them to not have to rely on a single vendor.

— *Support for installed base*: Telecom/datacom managers value solutions that can build on their installed base of information systems.

— *Access methods and speeds*: Telecom/datacom managers have needs for different access methods and speeds in support of applications solutions. These requirements are shaped by the installed base as well as by cost factors.

IDL SOLUTIONS FOR UNIVERSITIES

There are a number of application solutions available to universities in addressing their IDL needs. They are:

1) internet
2) groupware
3) one-way video/video-conferencing
4) two-way video.

Internet

Universities have been using the internet for over a decade. The major uses are:

— *Access to libraries and databases:* University students can access hundreds of libraries around the world, as well as library catalogue and full text-service delivery services, through the internet. The internet also enables university students and researchers to access a wide range of government agency information, such as space shuttle updates.

- *Collaborative learning:* University students can rely on a number of internet services in collaborating with each other. These services include e-mail, logon services, file transfer, host-to-host communications, and directory services. These applications enable university students to establish a dialogue with other researchers and scientists around the globe. It also enables them to transfer large files. In addition, through electronic whiteboards university students can share in real-time notes about specific technical topics.
- *Remote learning:* One of the growing capabilities of the internet is video-conferencing. The internet has demonstrated the ability to link multiple sites though entry-level two-way video-conferencing links.
- *Access to supercomputers:* The internet enables university students and researchers to access major supercomputer centres throughout the country.

Due to its low cost, support for a wide range of applications, and ability to provide university students and researchers with access to a range of information resources, the internet will continue to be a key networking and communications solution for universities.

The internet solution provides students, researchers, and teachers with freedom from the constraints of time and space, interactivity, and instructional feedback. It has one major limitation, however, that universities need to take into account in selecting the applications supported by the internet security.

Violations result from unauthorised password use, particularly given the emergence of programmes collecting names and passwords on the network.

Groupware solutions

The groupware is an emerging alternative solution to the internet in meeting the needs of universities for intra-university IDL applications.

The key intra-university applications supported by groupware are the following:

- *Collaborative learning and research:* Groupware enables students to collaborate in real time on projects. Through groupware massaging applications, university ·students can submit their homework to teachers via e-mail, leave messages, or inquire about specific problems they are encountering in solving a specific homework assignment.
- *Access to databases:* Via groupware, the students can access public databases, private databases, fax, paging, voice mail, etc.
- *Remote classroom:* Groupware can complement desktop video-conferencing in conducting small classrooms. Through a small window on desktop workstations, university students are able to establish video-conferencing sessions with remote teachers.
- *Student/teacher and student/student interactions after hours:* Students residing in dormitories can exchange messages with teachers and other students, through groupware.

The major benefits offered by groupware includes the following:

1) *Low cost*: In implementing groupware, telecom/datacom managers incur a non-recurring cost.
2) *Multiple applications*: Groupware supports multiple IDL applications.
3) *Ease of use*: Multi-functional groupware solutions are based on GUIs, which makes them easy to use.
4) *Secure*: Groupware provides a secure solution for intra-company communications.
5) *Training and consulting*: The leading providers of multifunctional groupware provide their buyers with training or consulting.

Satellite-based or terrestrial-based business-TV solutions support the establishment of remote classrooms, enabling university students in remote locations to watch a teacher though a one-way video link and to ask questions through a two-way audio link. The one-way video/two-way audio solution provides university students with the ability to ask questions and interact with other students in other locations.

The one-way video/two-way audio solution is beneficial not only to university students but also to telecom/datacom administrators of universities for the following reasons:

i) A large number of satellite-based providers are currently available.
ii) Satellite and fibre systems deliver high quality pictures.
iii) The cost of one-way transmission is much less than the cost of hiring a teacher.
iv) There is support for inter-university and intra-university networking solutions.
v) The satellite-based one-way video solutions has a regional or national geographic coverage.

However, the one-way video/two-way audio solutions have their limitations:

i) The major problem with one-way video-conferencing systems to students is the accessibility of teachers.
ii) The relationship that develops between the student and the teacher through face-to-face interactions cannot be duplicated through the one-way video solution.
iii) Another problem is scheduling complexities, because in many cases, the daily transmission hours are often at odds with a school's own class schedules.

Two-way video-conferencing solutions

The two-way video-conferencing solution offers a potential improvement over the one-way video/two-way audio solution: interactivity. With this solution, all the participants can see each other, enhancing the collaborative learning process. However, its effectiveness depends on picture quality. The quality of the two-way video-conferencing picture, its affordability, and its geographic presence depend on the coding method and the networking solution provided.

Despite the benefits of this solution, it cannot on its own support all the IDL needs of universities. Data-oriented solutions, such as groupware and the internet, can complement the two-way video/audio solution in addressing the IDL needs of universities.

An example of a growing two-way video-conferencing solution is the Collaboration for Interactive Distance Visual Learning (CIDVL). This is a multi-institutional effort, which was formally launched in 1993. CIDVL consists of 11 universities and corporations seeking to create a "virtual university" environment, providing courses and lectures to one another in the field of engineering. Initial members of CIDVL were Boston University, MIT, Penn State, Rensselaer Polytechnic Institute, 3M Corp., AT&T, United Technologies, and PictureTel Corp. Other universities and corporations are entitled to join CIDVL as members by paying $10,000 for a three-year membership term. New members are also expected to offer their own intellectual contributions. Students enrol in a CIDVL course through either their individual university or corporation. University students pay per-credit fees to the remote institution offering the programme. Credit-transfer policies are arranged between the native university at which the student is enrolled and the remote university offering the course.

NETWORKING SOLUTIONS

To support the application solutions a number of key networking solutions are available. They include ATM-based solutions, fast-packet services, and ISDN primary rate interface.

ATM solutions

ATM solutions can provide universities with high transmission speeds and the ability to integrate data, voice, video, and multimedia communications. One university that has implemented an ATM-based networking solution is Duke Medical Center in North Carolina. Administrators selected ATM as both a LAN and a WAN solution to replace an Ethernet-based LAN infrastructure.

SMDS

SMDS can support the data-oriented IDL application solutions, including access to the internet and groupware communications. SMDS provides universities with several benefits, including cost reduction, support for high-bandwidth bursty data applications, flexibility, and security.

— *Cost reduction*: SMDS could be more economical than ATM PVC solutions, particularly when there are many sites to be interconnected. SMDS can also reduce university administrative cost if network connections of a university cannot be predicted in advance, or if these connections are constantly changing.

— *Extensive bandwidth capabilities*: SMDS provides telecom/datacom managers with a choice of various access classes, enabling them to start at a lower bandwidth level and than migrate the network to a higher access class as the communications needs warrant the upgrade.

— *Flexibility*: SMDS is flexible because it enables telecom/datacom managers to include corporations in their networks that do not justify the expense of a dedicated line.

Besides the benefits, SMDS has several shortcomings. It is defined to support packet data traffic. It cannot support a number of IDL solutions, including one-way video/two-way audio and two-way video/two-way audio solutions.

Frame relay solutions

Frame Relay Solutions (FRS) is emerging as a distance learning networking solution that can complement or substitute for other networking solutions, such as SMDS, NMLIS, and ATM CRS. As already noted, FRS is a data-only, connection-oriented frame-transport service that uses virtual connections. Statistical multiplexing techniques are used to support PVCs and, in the future, SVCs. FRS on the market tends to be PVC-based. A PVC connection is usually established when the service is provisioned at subscription time, eliminating the need for user-to network signalling. PAS supports access speeds of 56 Kbps, n × 64 Kbps, and 1.544 Mbps.

Frame relay provides universities with several benefits, including the following:

— *Economic benefits:* FRS offers higher transmission speeds, simplified network design, and low operating costs compared to earlier packet services.

— *Availability*: FRS is widely available and is currently supported by IXCs, LECs, and RBOCs.

The frame relay technology has several shortcomings, including lack of support for isochronous traffic, complex administration, bandwidth limitations, inconsistent product offerings, transmission delays and so on.

ISDN

It provides universities with another data and video communications alternative. This interconnection approach involves the use of switched digital facilities to link a student with a training site located across the city or the country.

ISDN provides n×64 Kbps end-to-end digital connectivity with access to voice and data services for the same digital transmission and switching facilities. The more well-known interfaces are 2B+D, which provides two switched 64-Kbps channels, plus a 16-Kbps packet/signalling channel, and 23B+D, which provides universities with DS1 speeds.

ISDN is now seeing a renewed push toward deployment. It can support the following IDL applications:

— *Access to Internet*: RBOCs are increasingly addressing the needs of universities for access to the internet through ISDN solutions.

— *Access to groupware*: ISDN can support both public and private groupware solutions.

— *Two-way compressed video-conferencing solution*: The RBOCs are developing this capability to meet the needs of universities.

ISDN provides universities with the following benefits:

— *"Wideband" bandwidth:* A group of ISDN solutions are available that can support the bandwidth needs of universities for lower-end video-conferencing solutions.

— *Availability*: The RBOCs have been actively deploying ISDN to support the networking needs of universities, as well as other applications.

DISTANCE EDUCATION AND MEDIA

In order to make education accessible to all and to make it meaningful, exciting and interesting, a new technology need to be linked with the process of learning. The new technology is not only capable of overcoming the barriers that distance presents, but also changes the very nature of the instructional process. It is technology that made the move from correspondence to distance education possible.

If the demands of the society for education are to be met successfully, we will have to switch over to an alternative approach of unconventional mode of distance education through mass communication technology currently available. Modern communication technologies have the potential to bypass several stages and sequences in the process of development encountered in earlier decades. In order to avoid structural dualism, modern education technology must reach out to the most distant areas and to the most deprived sections of beneficiaries simultaneously with the areas of comparative affluence and ready availability.

Media is a kind of message of delivery system which includes all kinds of mechanical devices directed to educational use. These devices are used as means of communicating our ideas to large number of people who are located in far off areas. Choice of media is crucial where there is no provision for face-to-face interaction and the students depend on print material with occasional face-to-face support.

Distance education programmes can be enriched and made more attractive, effective and satisfying by using a variety of media relevant to the content for learning and the facilities that can be provided should attempt an exploitation of the potential of the variety of powerful media provided by modern technology.

The educational media was confined to classroom lectures supported by print material. Education was imparted with the help of maps, charts, pictures, books, diagrams and till recently through using 11 mm projectors for educational purposes. Actually the 1970's were the decade of print. The present day mechanical devices have brought about a virtual revolution in diverse field of human activity.

A variety of media are used in distance education in open universities as well as in institutes of distance learning. They can be classified into two groups: (a) print media and (b) non-print media.

Print Media

Distance education cannot do without printed course material. It is the mainstay of the instructional system almost everywhere. It is in the form of reading material or in the form of programmed instructional material. It is the most popular medium because it is easy to carry, is comparatively cheaper and can be used according to the convenience of the learners. The learners get the self-instructional material at their homes by post. The material is carefully prepared by experts in the field of their expertise to suit the needs of the learners and to help them learn the subject without much assistance from others.

Non-Print Media

The area of non-print media includes the technologies such as radio and television, telephone, videotex, computers, internet, satellites and so on.

Radio

The radio has become one of the most powerful media of mass communication in the modern age. It is being increasingly used in advanced countries to overcome the shortage of qualified teachers and suitable books. It can enrich the farthest corners. If the radio has become a necessary instrument of education in advanced and progressive countries, the services it can render are still far greater in a country like India.

As a matter of fact, the radio is an effective medium and has been extensively used for educational purposes to spread literacy or to give formal or non-formal education all over the world. In addition to the printed materials lessons are planned and written for broadcast from All India Radio.

Radio programmes supplement and reinforce instruction imparted through the printed material. The radio is within the reach of the common man and can be carried along from place to place.

Television

The television is a more effective medium than radio for spreading education, because the language of TV is rich, powerful and expressive. TV lessons are entertaining as well as attractive. A lesson received through the gates of eyes and ears has a double chance of retention by learners. The television screen may become the electronic blackboard of the future.

Radio and television are not teacher substitute but teaching aids only. They are very useful, produce more elaborate illustrative material, have tremendous potential but they cannot stand on their own. In India also the majority of the students of distance education have started making use of TV for educational purposes. The UGC programmes are becoming very popular these days.

Audio-video cassettes

The audio/video cassettes can be played and replayed at home by the learner at his/her will. A learner can stop a particular tape at a point where more details are necessary and can play in slow motion to understand a difficult point. He need not get up early in the morning or wake up late in the night for radio and TV broadcasts. The use of video enabled a good lecturer to be seen and heard all over the country, without having to repeat his performance. At the moment, the video equipment is costly in India and even in other developing countries and they are not within the reach of most of the students.

Telephone

The telephone is a very effective means of communication. It offers two ways interactive communications across distance, i.e., people can talk to each other, discuss and ask questions. In India this is unlikely to be considered as a medium in distance education.

Videotex

The videotex makes home television sets to function like a computer terminal and retrieve text information and graphics from a remote database. It gives much wider access to information and much wider ease with which new concepts and ideas can be transmitted.

Computers

The mass teaching system has become virtually impossible without a computer. The computer is a very good tool to improve the process of teaching and learning. It is of tremendous use for teaching and learning in diverse situations. Computer based instructions include a broad range of applications. The major classification of computer application for distance learning are "Computer Assisted Instruction and Computer Management Instruction". The target number of students must be large because of the special skills and time required to develop effective computer-aided instruction.

Internet

The internet is the largest, most powerful computer network in the world. It encompasses 1.3 million computers with internet addresses that are used up by 30 million people in more than fifty countries. As more colleges, universities, schools, companies and private citizens are connected to the internet either through affiliations with regional not-for-profit network or by subscribing to information services provided for profit companies, more possibilities are open for distance educators to overcome time and distance to reach students. The easy availability of computers and worldwide internet has brought about significant changes in learning-teaching strategies.

In United States and Canada, every student has an e-mail account and has either a computer of his own or has easy access to the university computer system. This has solved to a great extent the problems of student and teacher interaction. The present electronic communication system has made the interaction much easier and essentially less costly.

With the access to internet, distance educators and their students can use the Electronic Mail (E-Mail), Bulletin Boards and World Wide Web (WWW). The WWW and web browsers have made the internet a more user-friendly environment. The ability to integrate graphics, text, and sound into a single tool means that novice users do not have to struggle with such a steep learning curve. In addition, organisations and individuals can create home pages on their own computers or to pages created by others on different computer systems.

In India, the UGC, the universities and the academic staff college can play an important role in bringing about this computer and internet revolution provided our college teachers and our research scholars are ready to use the new technologies to accelerate the pace of learning.

Satellite

The satellite is the glamourous medium in distance education. It is used for communicating over long distance. More channels for both radio and television are possible because of the satellite. Programmes are viewed by people in cities as well as in countryside locations. The satellite and television network offers a powerful medium for the dissemination of knowledge, cultural programme and developmental information. A wide area is covered without any loss of quality in the messages sent. The communication channels are not affected by natural calamities as is usually the case with telephone wires.

All teaching and learning programmes can be greatly improved by visual and auditory materials because these make the learning experience far more concrete and memorable. But the media has remained under-exploited by the distance learning system for want of appropriate and relevant software which is the greatest problem of this system. India is making a mark in distance education and we need to develop and grow a large number of efficient, committed and trained media persons to implement new technologies in this field.

3

Electronic Distance Education (EDE)

TELECOMMUNICATIONS TECHNOLOGIES

A national effort is underway by both private and public sectors to build and expand electronic-based information highways. These information highways provide the infrastructure to change the nature of educational delivery from a traditional classroom to a "virtual" classroom that is more geographically distributed. While these electronic approaches to improving the education dilemma in rural areas seemed the long-awaited "magic pill", a review of literature uncovered some serious issues with EDE (Electronic Distance Education). These concerns included questions regarding the instructional effectiveness, methodology and design of some previous EDE courses.

During several studies, researchers have reported poor cognitive performance and increased attrition. Electronically Mediated Instruction (EMI) through distance learning technology is still a rather new domain. Initially, distance educators simply duplicated the teacher-centred formats typically found in the traditional classroom. This resulted in disastrous "talking head" presentations. The computer-based distance learning machines offered a barrage of electronic attributes, such as sounds, colours, lights, animations, and video sequences, the learner became enamoured of this awesome technology and missed the intended instructional message.

Some educators felt that students using electronic technologies frequently were subjected to fast-moving entertainment-type experiential experiences possibly at the expense of the reflection necessary to complete the mental processes of learning. This so-called "edutainment" process adversely hampered student cognitive achievement and reduced student motivation to continue, thereby increasing attrition. Finally, most students were accustomed to having instructors present in the classroom to provide extrinsic motivation.

Studies have shown that without visible classroom leaders, some students felt isolated, unmotivated, and cognitively disoriented. This ultimately increased attrition at higher rates than for those students who participated in conventional classroom courses. One possible new paradigm mentioned in the literature involved using learner-centred approaches for EDE. Payne and Stoddard suggested that there were wide-open possibilities for research into the benefits of such designs, especially in the area of EDE-based technical training such as found in EMS courses.

Statement of the Problem

While emerging EDE technologies may deliver onsite education, there seemed be justifiable concerns that the resulting "virtual" instructional environment may be woefully inadequate. It appeared that EDE instructional designers needed to develop new learning strategies, such as those found in the emerging constructivist learning models. The purpose of this study was to determine if students who take instruction delivered by EDE incorporating constructivist models could have scores and attrition rates equal to those students who take the same instruction delivered in the traditional classroom.

The study also sought to determine if there was a difference in scores and attrition between those students in the two EDE courses which were taught using different distance education technologies. The Texas Bureau of Emergency Management, mandated by state law to certify EMS courses, readily approved traditional class, but seemed hesitant to approve EDE courses.

Treatments

The two-year study conducted in rural central Texas communities involved volunteer EMS students who attended one of three types of emergency medical technician-intermediate courses. Students in the control group (n = 25) took the instruction in a traditional classroom setting. The other two groups received training via two separate EDE systems (n = 18).

The first was a two way audio/graphic network incorporating standard telephone communications, and the second was a two-way audio/video system linked by a NASA satellite (n= 14). The type of course was assigned randomly to each community involved in the study. Students from the same communities were placed in the same study group. An analysis of the student demographics showed no significant difference (p = .07) in gender, age, or level of education between the groups. All students took a standardised 174-question multiple choice post-test. Attrition rates were based upon the number of those who qualified for EMT-I certification testing at the conclusion of the courses.

Methodology

The instructor chiefly delivered lectures to the students with some audiovisual support. For the students in the two EDE courses, the study sought to overcome the previously mentioned problems with EDE using two corrective approaches.

The first involved developing an appropriate instructional model, and the other provided additional extrinsic support to the learners so they would want to complete the courses. The instructional strategies selected for the two EDE courses followed the recommendations of Williams and Paprock. In their constructivist-based model, the responsibility of learning shifted to the student, and the instructor became a facilitator.

The students became proactive, rather then reactive. To accomplish this shift, instruction delivered at the distance sites progressed through three well-structured stages. This allowed the locus of control to transition gradually from teacher-centred to learner centred as each lesson progressed. These three stages, which are elaborated in table 2, include: (1) teacher-directed teacher-centred (objectivism), teacher-directed learner-centred (constructivism), and (3) learner-directed/learner-centred (collaborativism, a form of constructivism). Before teaching the two distance education courses, the instructor participated in a 12-hour telecourse. When presenting the lessons in the EDE treatments, the instructor opened each lesson with a brief lecture on a specific medical topic. This information supplied the students with the cognitive base for them to move into the constructivist sections of the instruction later. After the initial lecture, the instructor directed interactive exercises in which individual students responded to questions or interacted with the material displayed on the computer screen or video-conferencing monitor. When this activity ended, students separated into small groups.

The instructor then presented a video-taped emergency care scenario or introduced a detailed case study. Each group proceeded at its own pace and sought its own resources to derive unique solutions. At the close of these collaborative sessions, each group explained its solutions to the other groups. Group members interacted with their peers in defending their solutions and arriving at a consensus. The instructor facilitated the discussion and provided feedback. The electronic attributes of the EDE delivery systems cued or enhanced the instructional message, not detracted from it.

Attrition

There were three specific ways in which this study attempted to reduce the increased attrition previously reported during distance learning studies. The first was to include constructivist models when designing lesson plans. These approaches gave students a sense of power and ownership of the course, thereby increasing intrinsic motivation and reducing attrition.

Secondly, in the light of studies that indicated providing supplementary materials and additional feedback decreased attrition during EDE programmes, the investigators installed computer-based training (CBT) workstations in the rural ambulance stations. CBT seemed to best complement the personality profiles of emergency workers.

The interactive CBT software modelled an instructional design adapted from Gagne, Wagner, and Rojas. Their model progressed learners through nine external "events of instruction" that complemented the internal cognitive processes of learners. The design included appropriate, immediate feedback throughout the tutorials and drill and practice sessions. As with the distance education technologies, attributes such as colour, sound, graphic, images, animations, and text, purposely delivered intended cues or specific messages.

Table 1

General personal traits of emergency personnel as complemented by the attributes of computer-based training.

Identified Personality Trait	*Contribution of CBT*
Need to be in control	Provide menus at key junctions and include choice bars at the bottom of each screen so users can choose instructional paths.
Compulsive	Allow adaptive software designs that prompt and/or suggest that the learner take particular paths of instruction based on the learner responses to interaction sequences.
Action oriented	Include as much interactivity as possible that requires active, ongoing input from the learner to proceed through the lesson.
High need for stimulation	Provide realistic simulations of emergency situations.
Need for immediacy	Provide immediate feedback and gratification remediation screens for all learner responses.
Easily bored	Include appropriate attention-getting electronic devices such as animations, graphics, sounds, and digital video sequences.
Risk takers	Allow learners to explore and experiment with the new technology.

Thirdly, the instructor used telephone communications during and after the course to help students who needed clarification, elaboration, remediation, or feedback as dictated by academic performance. These procedures enhanced rapport between the instructor and those individual students who were falling behind in the courses and discouraged attrition.

DATA ANALYSIS

Mean post-test scores were compared using ANOVA with 95 per cent confidence intervals incorporating the student's t-test method. The attrition rates were based upon the number of students completing the course and being eligible to take the state EMT-I certification examination. These attrition rates were compared using Fisher's exact test with 95 per cent confidence intervals computed by the exact binomial method. The level of significance for statistical measurements was established at $p < .05$.

Table 2

Analysis of the reliability of the post-test instrument

Group	*n*	*Average correct*	*KR-21*
Classroom	22	158	0.80
Audio/Graphic	18	162	0.72
Satellite	12	161	0.78

Table 3

Analysis of post-test scores between the three treatment groups

Group	*n*	*Mean score +stddev*	*Range(Median)*
Classroom	22	93 ± 4	81 to 98 (94)
Audio/Graphic	18	94 ± 3	90 to 99 (96)
Audio/ Video	12	94 ± 4	86 to 99 (95)

Results

A reliability coefficient of 0.70 or higher as recommended by Nunnally was adopted as the acceptable reliability coefficient. The results, as shown in table 2, indicated that the reliability of the post-test instrument was acceptable for all three groups. Mean post-test results for each group were as follows: Control group = 93 (95% CI = 91-95), Audio/graphic group = 94 (95% CI = 93-96), and Audio/video group = 94 (95% CI = 92-96). An analysis of data showed that there were no significant differences ($p = 0.21$) in the post-test mean scores of the three groups.

Given the number of students, mean test scores, and test score ranges, post hoc calculations indicate a power of 80 per cent to detect a four point difference in mean test scores between the groups. Attrition rates were as follows: Control group = 88 per cent (95% CI = 69-97%), Audio/graphic group = 100 per cent (95% CI = 81-100%), and Audio/video group = 86 per cent (95% CI = 57-98%). There were no significant differences ($p = 0.24$) in the attrition rates of the three groups.

The five students who dropped from the courses listed "personal reasons" for quitting. As expected, the instructor made significantly more telephone calls to help the students enrolled in the EDE groups than to the control group.

INTERACTIVE DISTANCE EDUCATION NETWORK

There are several advantages to an educational institution and the students for offering courses on an interactive distance education network. Courses and/or programmes of study which have chronic low enrolments may find that adequate numbers of students are available by combining several instructional locations through an interactive network. By following this course of action there is a greater possibility of more courses making enrolment minimum, which is needed by the institution, and also supports the needs of the students who are enrolled in these programmes.

The process of offering low enrolment course to multiple sites also becomes more economically feasible for the institution. Another advantage is that students are offered a variety of instructors and instructional styles through the interactive network which may not be available on a single campus. By interacting with instructors from other locations, the students are exposed to different ideas and techniques which they might not encounter on their own campus. Even the interaction with the remote site students can provide new and expanded learning possibilities for not only the origination site students but also the faculty. The interactive component of the distance education network can offer learning opportunities for the students other than those provided by the instructor.

One approach for using this technique is the integration of guest speakers. Through these individuals the students can be provided with pertinent information that is currently being utilised in that particular field. The network allows speakers to interact with students at the origination and remote sites.

The network can also allow the guest speakers to be located at remote sites from the classroom instructor. A major advantage associated with interactive distance education for the student is the exposure to new and advanced communications technology. In the "real world" of work, being adaptable and receptive to new and emerging technologies is a primary asset for the student in the quest for professional and economic success and advancement. Students should experience these technologies as much as possible in the classroom to fully understand how they can be integrated into the various work related operations that exist today.

The simple classroom lecture can no longer provide all that is needed to ensure the success of the students once they have completed their degree programmes and begin work. As with all innovative endeavours, there are certain inherent problems which must be identified and solved to insure the effective operation of the interactive network. This is especially true when working with technologically advanced systems such as those utilised for interactive distance education.

Therefore, it should not be a surprise that the first problem relates to network downtime. Any electronically supported network will face the usual array of problems such as electrical power interruption, malfunctioning equipment, and communication line problems. Although most of these situations are beyond the control of the distance education administrator, efforts must be continually made to eliminate all manageable network problems. Another problem concerns the instructional materials the faculty use for their interactive classes.

In many instances, the instructional materials which the faculty incorporate into their "regular" classes will not translate completely to the interactive environment because of the network hardware. Therefore, if the faculty do not receive appropriate training on the design and utilisation of instructional materials for this particular network, then an extensive amount of time will be lost during the term trying to catch-up in this important area. Faculty training should be based on the type of hardware that makes up the interactive technology of the network. The utilisation of instructional materials for interactive distance education classes also faces another extensive problem in the area of copyright.

The federal copyright law provides for the limited use of copyrighted materials for instructional purposes through the Fair Use guidelines. However, the concern for the distance educator and copyright relates directly to the technology that is an integral part of the interactive network. The integration of multimedia programmes on an interactive network further extends the problem of copyright since this area also has many questions about fair use which have not been answered at this time. For the faculty and distance education administrator, the rule for the use of copyrighted materials on an interactive network is one of caution. No one wants to become a test case for a copyright violation.

Therefore, if there is some question about whether an item meets the fair use guidelines, then it should not be used on the network. One problem that is a concern for faculty is the administrative components of the interactive course as they relate to both the origination and remote sites. Such aspects as class scheduling, office hours for remote site students, course and program counselling, transporting class materials and tests, will all have a varying degree of impact on the effectiveness and efficiency of the course and the instructor.

Instructional experience

Learning is active and student interaction is an essential component of any interactive distance education course. Simple things such as knowing the names and asking questions of specific students at all sites will facilitate the interaction process. The faculty member should also look at the camera broadcasting the video signal to the remote sites approximately once every twelve seconds to give the impression that he is looking directly at the remote site students. There is also a tendency for faculty to look at the remote site monitor located in the front of the room when talking with the remote site students. This gives the impression of the faculty member talking to the side of the monitor instead of directly to the remote site students. This situation can be avoided if the faculty member will always look and speak directly into the broadcast camera which should be located on or close to the remote site monitor in the back of the room.

Interactive distance education requires a constant attempt by the faculty to ensure the involvement of all students at all sites with the course, materials, instruction, and other students. Modifications to the individual teaching style of the faculty can also be the result of the various equipment components which make up the technology for the network. Although the lecture is still the major instructional technique with interactive classes, the chalkboard as a support component has basically been replaced with the documents camera.

A faculty member that walks or moves about the classroom extensively during his normal teaching style sometimes finds it difficult to adjust to the interactive distance education environment. Although a wireless microphone can be used, by restricting the movement of the instructor with a microphone cable, it is easier to keep him in frame so that the picture received at the remote site is not distracting to those students.

This is a very important consideration since all the remote site students have for instruction is the picture on the monitor received from the origination site. The success of any interactive distance education program will require extensive training for the faculty before any classes are offered on the network. Instructional planning for the faculty is a very important part of the training process. This concept is supported by Price and Repman when they state that the effectiveness of courses delivered over a distance, like face- to-face instruction, depends on the planning of the course, class activities and the instructional materials used.

The need for appropriate faculty training in all aspects of the interactive classroom is imperative to insure that the instructional planning and presentation process will meet the needs of both the faculty and the students to be served. Administrative considerations within the training process for the faculty would include such components as instructional support materials, lead time for getting materials to different sites, hardware/software availability, local library facilities, classwork/ homework, and tests.

Although these items may seem insignificant in relation to other instructional problems, each of these components will require extensive planning by the faculty to insure the smooth operation of the interactive course. It should also be noted that adequate preparation time must also be provided to the faculty in the development of appropriate instructional materials for the interactive course.

The instructional materials utilised for traditional classes do not always fit into the technology of the interactive classroom. One area of research that is of concern for the faculty relates to the attitudes of students who have taken courses through interactive distance education. Results from this research can assist faculty in the planning of an interactive class in order to avoid potential problems identified with other distance education endeavours. Interaction between the faculty and the students at all sites, but particularly at the remote sites, is one aspect that has proven to be an essential component to the success of any interactive class.

The goal of interactive distance education is “to make the experience of the remote student comparable to the experience of the local learner”. Therefore, the quality and academic integrity of interactive distance education will suffer if the educational experiences provided are not the same for all students at all sites.

LECTURES AND ELECTRONIC COURSE MATERIALS

Teaching and Learning

The history of educational technology is littered with the high hopes and limited success of radio, film, TV, video, teaching machines, stand-alone computers and CD-ROM. If the facilities offered by computer networking and the still developing WWW are to fare better in the educational context than its predecessors, it must be closely integrated with tried and tested conventional teaching methods, and viewed neither as a panacea nor as a bolt-on extra.

This point is clearly articulated for computer-assisted learning (CAL) by Tickner who suggests: “The most important factor in the successful implementation and student uptake of CAL in HE is thorough, planned and supported integration with more traditional teaching media”. It is flawed to think that if the delivery mechanism for information is correctly designed then people will team.

Knowledge is not information but an emergent property, “knowledge is a dynamic process, a vibrant, living thing, resting on shared assumptions, beliefs, complex perceptions . . . and the ability to ‘go beyond the information given”. In higher education the aim must be to develop students’ critical faculties, understanding and independence of thought, and this implies much more than simply employing an alternative medium for the distribution of teaching materials. Any teaching approach must match the needs and capabilities of a particular category of students and the course content. The students involved in the work reported here were final-year undergraduate students, who had completed two taught years on a BSc in Computing and Information Systems and one year on industrial placement.

The students were accustomed to accessing files over a Novell network, and most were familiar with the WWW, though not all had used file transfer protocol (ftp). The module involved was on Human-Computer Interaction, in which students can benefit greatly from exposure to a wide range of user interfaces. It also has a higher visual component than most other topics in computing.

The subject area at this level has a rapidly changing knowledge base—perhaps around 10 per cent needs to be revised each year, particularly the examples of best practice. The teaching context also contributes to the appropriateness or otherwise of a teaching and learning strategy. The University of Ulster has adopted a fully semesterised teaching year. These final year students take three modules in the space of 12 teaching weeks, with an allocation of five hours per week for lectures, tutorials and supervised practical work. Even a brief absence can mean missing a significant portion of a course.

However, making course materials readily available by means of a computer can partially compensate for this problem. Over the last decade student numbers have increased year after year, so that this final year option now attracts some 45 students. Computer network and laboratory facilities available to computing students are adequate in quantity and excellent in quality. The primary teaching and learning aim was to facilitate more 'deep' learning. In the hierarchy of the cognitive domain, lectures are appropriate for conveying 'surface' learning, in the form of knowledge, manipulation and application. This is essentially knowledge which can be made objective, formal and explicit and directly accessible.

For 'deep' learning, where the student applies analysis, attempts synthesis of concepts and evaluates what has been done, largely subjective and tacit knowledge is involved and this comes through experience and dialogue, and therefore is supported best in tutorials, practicals and other forms of group work. The secondary educational aim was to provide more support for different learning styles. That individuals differ in the way they process, absorb and remember information is well-established. There are various categorisations of learning styles. Some students like to have information presented in a step-by-step, cumulative, sequential manner that develops the concept. Others learn best when they are first presented with the general concept and then the details.

Some prefer to work cooperatively while others prefer independence. There is also some evidence that female students have a marked preference for face-to-face communication. Although it may not be possible to accommodate everyone's style of learning, the provision of a variety of course materials (electronic and conventional) will go some way to enabling individuals to employ their own preferred learning style.

THEORY AND PRINCIPLES

Information presentation starts the conceptualisation phase. Subsequently, concepts are iteratively refined, understood and internalised by action—applying the knowledge in performing meaningful tasks, such as in practicals, assignments or projects. Mayes argues strongly that "Dialogue is fundamental to education. It is, of course, possible to learn without discussion, but the need to support deep learning through tutorial and peer-group dialogue is paramount".

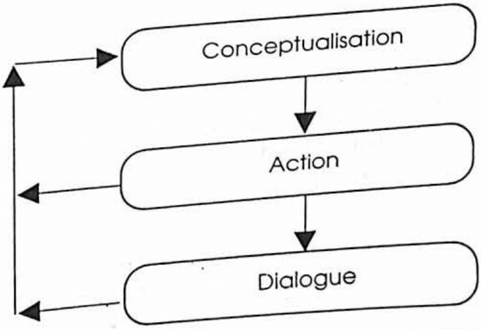


Figure 1: The learning cycle proposed by Mayes.

The lecture is an efficient and cost-effective way of communicating knowledge, but on its own it promotes surface learning and does not provide the appropriate context for deep learning. This form of provision may also tend to promote relatively passive learning strategies focused on memorisation and inhibiting the development of decision- making skills. The most conventional forms of dialogue in higher education include one-to-one discussion, tutorials, seminars, peer group working and written feedback on assignments. Indeed, it has been claimed that appropriate assessment and feedback are the most effective differentiator between the best and worst courses.

Students need to be able to ask questions to correct misconceptions. It is important to get them working together, to share insights and identify common confusions. Presenting students with information in some form and through some medium, while a necessary step, is by no means sufficient to define an effective teaching and learning strategy. Viewed from this perspective, learning is a by-product of understanding, where understanding occurs best through performing tasks, and reflecting on them alone and with others. While excellent online material, perhaps produced by a well-resourced team of subject, pedagogic and presentation experts can greatly reduce the need for live lectures, the economic forces in the UK university sector are pulling in the opposite direction.

Although some nationally funded courseware is beginning to show that such an approach can be applied successfully in the earlier years of university teaching, where course content changes relatively slowly and is targeted at large numbers, it is much less applicable to final year undergraduate or postgraduate courses, here content changes more rapidly, and where separate modules are taught to fewer students.

Moreover, the live lecture is not only highly effective for explaining concepts, but can also motivate and convey enthusiasm, and with it an appreciation of the value of the subject, set learning goals, add humour and asides, provide a developing overview of information, point to resources, keep students to at least a minimal reading and practical schedule and provide a social setting. So the lecture has many advantages, and, of course, represents no additional costs to the educational institution. In moving to increased levels of electronic support, retention of lectures also reduces any risk to the education quality or to the students' examination chances.

REVISED TEACHING AND LEARNING APPROACH

Rebalancing the Human-Computer Interaction module took the form of reducing the time devoted to lectures (from a previous four hours to three hours per week), maintaining the supervised practical content (at one hour, with existing demonstrator help but through online support increasing what students could achieve in that time), and establishing a tutorial system so that students would have 30 minutes per week in groups from 10 to 12 in size.

A reduction in course content would not have been acceptable, so the lecturing strategy involved delivering the material at a more rapid pace than in the past, knowing that students could review all lecture materials outside class time. Students were also required to read a specified course textbook and other printed references held in the library.

The contents of the electronically available resources are outlined. Students' freedom to inspect or indeed ignore any or all of this information represented an extra dimension of student responsibility for their own learning not offered in previous presentations of the module. The main advantage to the students was that all the electronic materials for lectures, practicals, assignments and background work were continuously available. While their printed notes contained the bulk of the course slides and practical exercises, the visual quality of the on-screen slides exceeded the printed versions, and offered colour and high-quality image reproduction which added greatly to some of the topics covered.

In this way students could review all slides presented during lectures in their own time and at their own pace, If new slides were introduced during the course, the students knew that they could review them later, and did not become highly anxious scribblers when they were shown during lectures. Several videos or video clips were shown during the lectures. In the past, some students have asked to borrow the tapes after class, an option which is less viable with larger group sizes. By electronically providing summaries on PowerPoint slides, students found this review facility adequate, and there were far fewer requests for video loans than in previous years.

These video review files were particularly heavily accessed during the end-of-course revision week. During the year the ScreenCam product by Lotus was used to provide some multimedia course materials. This product records dynamic screen content and optionally a sound track. It proved particularly valuable for recording animated demonstrations of user interfaces of key relevance to the course. Depending on the screen content and movement, a IMB file would record about five minutes of animated demonstration. Spoken commentary could be added, but at an additional storage cost of about IMB per minute, and was therefore used sparingly. These animations were each shown once during lectures, but most students looked at them again in their own time, and enjoyed the control provided by the replay, pause, and fast-forward facilities of the viewer, allowing them to examine details as closely and as often as they wished. The first consideration in rebalancing use of available class time, to reduce lecturing time without sacrificing quality of exposition or motivational impact, fitted in with the author's evolving lecturing strategy.

Over the years teaching slides have been developed and refined, and now exist as some 550 colour PowerPoint slides. This year, as in the last three years, black and white miniatures of many of these slides were reproduced as notes for students, so that during lectures they have only been obliged to make marginal notes rather than the detailed records of the past, in which speed of writing and fear of missing important facts were commonplace concerns.

The printed notes have proved extremely popular with students. Effectively the course material development costs have been spread over several years, and experience has shown that the printed notes help to reduce the lecturing time for a typical topic by the order of one-third.

Secondly, it was important to maintain and develop the successful approach to practical and assignment work used in recent years. The students were provided with some 35 printed pages of structured practical laboratory work. They were advised to attempt the various exercises soon after the corresponding lecture, but were quite free to proceed at their own pace. Most followed the suggested timetable, but a few chose to progress much more quickly.

The full text of all printed practical materials was also available online, so that unavailability of a student's handout did not prevent practical work. Access to these files was not often required, but for some students occasionally enabled productive use of potentially wasted time. Online provision of relevant code fragments, samples of complete code or full simulations provided a rich set of resources which were extensively used and favourably commented on in informal feedback.

Thirdly, the topics considered in the tutorials were also tightly integrated with the lecture series. These sessions were highly effective in identifying and correcting areas of student misunderstanding, and of making students think through and attempt to apply concepts they had encountered. By this process of dialogue the students came to distinguish more clearly those topics they really understood and could apply from those they thought they knew, but had not adequately mastered.

Technical Implementation

From the start of teaching to the end of the examination period, a spare IBM compatible 80386 PC with 120 MB of disk storage was attached via a 10 Mb/s ethernet link to the local area network. Pilot work had used WWW server software to make relevant files available. Technically this worked very well, but it became evident that system maintenance could become burdensome—as a new file became available, a corresponding HTML file had to be edited. For the live trial it was decided to use an ftp server with robust performance and comprehensive control of access privileges. For most of the semester students used a Windows-based ftp client to gain read access to the prepared subdirectories and files, and were given write permission into an 'uploads' subdirectory.

Although use of the standard ftp client presented no difficulty to these computing students, an update of the ftp server software two-thirds through the teaching period allowed access by any WWW browser, in practice Netscape, and it immediately became their preferred access tool. This provided users with a familiar and easy to use interface, and accessing the ftp server now automatically generated a clickable list of subdirectories and files. By attaching PowerPoint and ScreenCam viewer software as helper applications to Netscape, students accessing slides or ScreenCam movies simply had to click on the required file.

Once material was placed on the ftp server, it was not modified, except to update announcements and correct typographical errors. This ensured that students had no anxiety that server contents would change unexpectedly, or that required information would be removed. Pilot work had indicated that it would be of value to record commentary for each lecture slide so that some material might be presented only in a 'lecture-on-demand' format. This plan was dropped largely in the light of experience elsewhere which showed that video-recorded lectures failed to be adequately engaging.

Also, although the sound reproduction quality was good, and was very acceptable when listened to in a quiet room, the background noise in a laboratory full of equipment and students became distracting after a few minutes. There is ample evidence that high sound quality is essential, otherwise users will abandon a presentation. It also became evident that the production of even near-professional sounding commentary becomes quite time-consuming, requiring full scripting, and often needing at least a second 'take' of the recording to eliminate minor speech flaws. In the absence of the sufficient time to prepare extensive materials, the use of recorded speech was limited to a small number of files. The ftp server made it possible to monitor usage patterns; however, access was deliberately made available by anonymous ftp to afford individuals privacy in using the resources. Inspection of server log files revealed the files that were of most interest, and students could be reminded of the presence of ones that few had accessed.

In discussing usage patterns at the end of the course, it became evident that some were much heavier users than others, but all reported accessing the server at least once per week. The relatively modest PC server supported the demand well. It was theoretically capable of serving 40 users simultaneously, but the observed peak of simultaneous access was only five. At that level, the response to the users would not normally have been much reduced, because most time in an ftp session is spent on inspecting subdirectory contents.

Changing to a different subdirectory normally involves transmission of only a few hundred bytes. In most ftp sessions only a few files were copied. The typical file of slides was around IMB in size, and this normally took from 10 to 20 seconds to transfer depending on general network traffic load. Students found the response time very satisfactory given that they would normally spend a considerable period looking at the file. It became evident soon after the start of the module that many students wanted to take files home, and they requested that the larger files should also be available in compressed format so that they would fit on to floppy disks.

The effort involved in providing a compressed copy for each large file on the server was minimal but much appreciated by the students. In requiring students to use ftp to upload software they produced for an assignment, the main benefit to the author was ease of access for marking (after checking for viruses!). Two side-benefits were, first, that the students knew the files would be time-stamped and that late submission would be very visible. Second, with agreement from the students, this coursework remained on the server and available for viewing by all students. When marked, students were informed of the highest scoring assignments, and most accessed at least one or two of these good examples.

4

Modular Distance Learning

Flexible modular distance learning (CBFMDL) mode of continuing education will play most critical role to carry out this gigantic task of updating and upgrading existing manpower as well as developing new technical manpower to satisfy constantly changing needs. It is, therefore, necessary to introduce competency based education (CBE) using flexible modular approach (FM) including, distance learning (DL) mode. As a short term gain, many countries are trying to achieve updating and upgrading their technical manpower without updating and upgrading the teachers of polytechnics and other TVET institutions. Such programmes of short term gains cannot be sustained in the long run. For any sustainable gain in developing world class technical manpower, it is most essential to first empower teachers of polytechnics and other TVET institutions.

These teachers of polytechnics and other TVET institutions have much higher potential to facilitate, and accelerate transformation of technical manpower into world class manpower to face highly competitive world market. Thus, updating and upgrading of teachers of polytechnics and TVET institutions must be made mandatory. This task can be accomplished through competency-based flexible modular approach under distance learning (CBFMDL) mode.

PHILOSOPHY OF TEACHER EDUCATION AND TRAINING

Economic and industrial growth of a country depends on capability/competency utilization of its people, especially workforce. Human potential and human resource development form the most critical aspects of productivity and quality output. We may have to adopt certain philosophical beliefs that every country has a vast store of untapped human brains, human talents, and human capabilities.

The first step towards human resource development is the discovery of this valuable human resource philosophy. People play key role in any improvement in industry, institution, or organisation and hence it is important to utilize the human resources to their optimum capability. Apart from many other conditions, one of the most important aspect of human performance is his "competence" based on knowledge, skills, and attitudes. Therefore, education and training enhance human performance by improving competence, confidence and commitment.

Education and training of workforce is closely related to education and training of teachers of polytechnics and other TVET institutions.

The key philosophical foundations of technical teacher education and training are the following precepts:

- A firm expectation that people will take both pride and interest in their work, if they are competent and capable;
- An unwavering recognition of dignity, respect and capability of every teacher without exception;
- A belief that each teacher desires to participate in improving the teaching/learning (TL) in TVET institutions;
- All TVET institutions involved in bringing about any change or improvement have to incorporate education and training of its administrators, teachers, instructors, and other staff;
- Human creativity can be achieved in a conducive environment and work culture;
- An orientation towards "Wholism" or importance of each and every member's role in meeting the institutional goal is key to success. The concept of teamwork, participation and integration of all the contributions for improvement is important.

Staff development programmes are job embedded with focus on development of competencies required for specific job activities leading directly to institutional improvement. Professional development programmes are job-related with focus on improvement of individual performance. Some of the job-related programmes could be credential oriented also. Career development include both job-embedded and job-related development. Considering these philosophical precepts and human development needs, there should be proper balance in objectives of education and training of technical teachers.

COMPETENCY-BASED EDUCATION

CBE is an effective alternative to rigid time-based conventional form of education and training. The conventional education and training system also aims development of competence of technician/graduate students. CBE is unique in terms of its underlying assumptions and characteristic customer-orient approach. There are several special aspects of CBE that distinguish it from traditional instruction. Although each, of these aspects may be found in conventional curricula it is their collective use that constitutes a true compete based education.

CBE has been designed to focus various key areas such as nature of competencies, criteria used to assess the competencies, ways to assess acquisition of competencies by learners, learner progress during the programme, and the instructional intent of programme. Competency reflects the ability to perform demonstrate knowledge and skills in contrast to traditional system of education. Competencies for vocational technical education are those tasks, skills, attitudes values, and appreciations that deemed critical to success in life and/or in earning a living. Every task cannot be classified as competency unless such a task forms a critical aspect of employability in the occupation. Every competency, then, evolves from explicit statements of worker roles. Since competencies align so closely an occupation, learner competence is ultimately assessed in much the same way as that of a worker. For correct assessment of competencies, the detailed competency statement must be designed clearly for the use of one.

Specific criteria of standards for assessment/competency should also be laid in addition to exhibition of performance and conditions under which competence is exhibited.

Criteria associate each competency have to reflect both the level of acceptable performance and the conditions associated with this performance. These criteria are also made available to learner and evaluators in advance to make things clear. The education system for competency attainment in TVET should strive for assessing learning in most realistic situation as far as possible. Although it may not be possible to assess competency of each learner on the job the assessment should be as objective as possible using the most realistic standards available. Student competency provides the primary evidence of achievement of objectives.

The teachers are required to focus on assessment that aligns with competence in the real world of work instead of traditional knowledge type subjective measures. The traditional curriculum is typically divided into clearly identifiable timeframes such as years, semesters, quarters, terms and weeks. These serve as starting and ending points for various portions of the instruction and indicate completion of certain phase of curriculum. In fact, learners do not always achieve the objectives or attain competencies at the same time. Learner abilities vary greatly to comprehend, read, write and apply the acquired knowledge.

Time-based traditional curriculum cannot effectively account for this wide variance of abilities. Competency-based education uses demonstrated competence as an indicator of learner progress towards programme completion. CBE enables students to proceed through a programme at their own pace based on their individual abilities, and thus, master specified competencies in a shorter (or longer) time period. The explicit intent of competency-based education is to facilitate student achievement of competencies specified in the programme. Each teacher is obligated to provide a sufficient variety of learning experiences so that learners will be offered an opportunity to master a minimum set of competencies. Here teachers and students are both accountable for student achievement. If students prepare a resume that meets specific criteria, the teacher is obligated to make available to students those experiences that facilitate the development of resume.

Teachers should include use of role playing, simulation activities, outside resource persons, and other techniques that enhance and aid each student's attainment of competence. Competency-based materials and relevant curriculum materials are most critical for a successful delivery of CBE. In a border sense, any material can be used in CBE but it is important to focus on how an item contributes to the development of student competence.

CBE material is developed on the basis of responses to the following important questions:

— Are competencies stated in the learning materials? Have the stated competencies been verified via some research base?

— Do objectives provided in the learning materials contribute to and align with stated competencies?

— Is sufficient emphasis placed on learning for application, not just for awareness and knowledge?

— Are meaningful instructions/suggestions provided to help students master stated competencies?

— Are learning activities/experiences provided to help each student master stated competencies?

There are many type of competency-based learning materials, but we may focus on representative types; the competency catalogue, the competency profile, and the module etc. Each has its specific purpose in context of CBE and may have greater or lesser application depending on the particular group of students, teachers, etc. Competency catalogue includes an array of competency statements relevant for a particular programme. The catalogue is based on:

(i) verified competency lists, and
(ii) the selection of a competency subject that satisfy local employment needs.

A consortium of Vocational and Technical Education at state or national level can prepare competency catalogue for numerous occupations that are based on extensive task analysis. These catalogues include informations on duty statements, task statements, task-related performance objectives, evaluative checklist etc. Competency catalogue is an employment referenced database used for curriculum development, instructional design, and programme design. Competency catalogue can be used for:

- duty category grouping tasks as testing domains;
- performance objectives as focal points for student learning; and
- performance guides as foundation for enabling objectives, instructional sequencing, test development, module preparation, and identification of prerequisites, etc.

Catalogue for exploratory programmes focus on educational process and lays less emphasis on standards and conditions associated with real employment. Competency profile indicates what competencies a student should learn and the record of competencies attained at the end of the programme. Competency profile which is also called skill record or employability profile is a document that lists competency areas required in an occupation and provides a means of assessing mastery of specific competencies. Although competency profile may vary in format, several basic elements are included in all profiles. Modular material plays critical role in delivery of CBE. Modular materials introduce flexibility and creativity in learning.

Modular material provides variety of opportunities to learners and to working professionals for their development through continuing education programmes. Modular material facilitates customised education and training programmes also. Modular material is based on mastery learning and hence it forms an essential part of CBE.

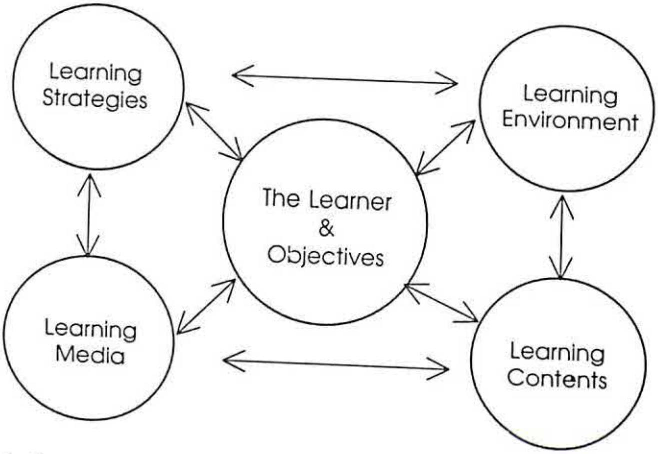
For making teachers conduct competency-based flexible modular programmes on distance learning mode, they should be first given education and training in development of competency-based learning material and management of such programmes.

FLEXIBLE MODULAR APPROACH

Flexibility in modular instruction refers to variety of contents, methods of delivery, media, time, pace, duration, and venue for learning. Modularity refers to building a certain competency (knowledge, skills, and attitudes) through a specific small learning resource which can be studied independently and forms part of a series of learning resources and ultimately leads to development or acquisition of desired competency/capability.

Modular approach requires development of effective modular materials (also called modules). Modules are developed based on principles of instructional design to suit special needs and circumstances of customers (students, employers, and society). These learning modules are developed on the following main considerations:

— learning environment available,
— learning contents required,
— learning media available,
— learning strategies and alternatives and
— learner background and objectives.



A module covers a single element of subject matter competency or group of competencies. In modular approach the whole programme is divided into number of modules arranged in predetermined sequence and grid. In the present context of rapidly changing technology and need of society, modular approach offers competitive advantage in preparing worldclass TVET teachers and technical manpower. Modules are one of the most promising innovative methods to provide learning opportunities to a large number of TVET teachers, working professionals and students.

Advantages

- learning along with jobs at own pace.
- learning in learner's own environment and style.
- used by single learner or group of learners.
- easily revised and updated to match developmental needs.
- offers flexibility of contents, time, style, media methods, etc.
- more cost effective in the long run and for large target.
- offers mastery of learning and better competency acquisition.

Module elements

Prerequisites are target group, well defined learning objectives and outcomes, practice tasks to involve learners, variety of media to suit individual differences, self-evaluation and feedback for motivation to promote mastery learning, well structured and sequenced contents leading to specific competencies/capability, end evaluation for credit articulation and certification, alternative study references and suggestions, etc. For the success of modular approach, the most critical thing is to develop appropriate well tested modules on the whole subject or programme area. Suitable need-based modules are required to be developed, tried and modified for study programmes before implementing modular approach in polytechnics and TVET institutions.

Following aspects are considered in the final assembly of modules to make them effective, efficient and economical:

- title to reflect contents appropriately.
- technical accuracy, relevance and up-to-date information.

- guidelines on how to use this module.
- overview, structure and glossary of terms.
- objectives and expected learning outcome.
- language simplicity.
- module division in learning units and subunits using Psychological principle.
- visually attractive, aesthetically pleasant format, captioning, and graphics.
- consistency in presentation style.
- pre and post tests and feedback.
- administratively convenient and economically viable and feasible.
- durability, etc.

Evidence indicates that modular approach is conducive to higher achievement as compared to conventional approach if suitable modules are available for learning. Modules offer excellent opportunities for flexible lifelong learning even along with employment.

Distance learning mode

India is passing through a very critical phase of development and facing the challenge posed by rapidly changing technology and market environment. A major challenge of TVET institutions is to provide continuing education and training for developing world class technical manpower to match the current and future needs of customers. To cope up with this gigantic task most of the TVET institutions will have to undertake continuing education and training programmes on a much larger scale to include distance learning mode. This has been emphasised from time to time and especially in national policy on education.

Distance learning mode envisages major portion of learning to occur at a distance away from the teacher. In distance learning the teacher acts as facilitator and the learner acts as decision maker and own instructor for learning in respect of pace, style, time, place, media, method, equipment, etc. If TVET institutions are to survive, competency-based flexible modular education and training under distance learning (CB FMDL) mode is an essential role to play. TVET teachers will first require education and training on how to conduct CBFMDL programmes effectively. Considering shortage of TVET teachers and other constraints, these programmes are required to be conducted as CBFMDL.

Competency-based flexible modular distance learning programmes will augment the efforts for accelerating industrial and economical growth in the country by:

- increasing the reach and access to technical education;
- increasing the productivity;
- increasing the employability;
- increasing the efficiency of technical education using NTT (New Training Technology);
- reducing the cost of technical education;
- reducing the inequalities of opportunities to disadvantaged section of society;
- reducing the gaps between need and supply of technical manpower;
- offering diversified in-house (on the job) competency based flexible modular education and training programmes;
- optimising the resource utilisation by networking; and
- improving quality of technical manpower.

All teachers of TVET institutions will have to be trained in the conduct of competency-based flexible modular programmes under distance education mode. Technical Teachers' Training Institute, Chandigarh has initiated some programmes for technical teachers under distance learning mode with certain minimum contact till adequate and appropriate facilities under distance learning mode are created. Presently these programmes under DL mode pertain to

- Certificate Course in "Education Technology"
- Advance Certificate Course in "Education Technology"
- Advance Certificate Course in "Educational Management"

Some teachers from polytechnics and industrial training institutes have registered under these pilot programmes but many more programmes are required to be launched from TTTI and then from various TVET institutions at different levels.

STRATEGY FOR TVET TEACHER DEVELOPMENT

For making TVET programmes relevant to the present context, TVET institutions will have to radically change and adopt various alternative approaches and alternative media based on latest information and communication technology (I&CT). To equip TVET institutions with various alternative approaches, TTTIs will have to play a critical role in developing TVET teachers. TTTIs will be required to carry out SWOT analysis and consider the following main factors to plan strategy for TVET teacher development:

- Customer Focus and Feedback Mechanism.
- TTTIs Leadership, Vision, and Mission Statements.
- TTTIs Reach and Access to TTTIs Programmes.
- Networking and Linkages for Optimisation
- Constraints and Possible Resistances

TTTI primary customers are polytechnics, industries and society. Apart from identifying customers, TTTI will have to establish and install in place feedback mechanism for getting customer needs for development of teachers and administrators on a continuous basis. Based on customer feedback on their needs and expectations TTTI shall carry out continuing education programmes to satisfy varied needs using various alternative approaches and modes.

TVET teachers shall be trained to develop and use delivery mode based on primary and secondary customer needs. Electronic media such as NTT, VSAT, IT", etc., may also be used by TTTIs to off er education and training programmes to TVET teachers. This will enhance the reach of TTTIs and increase access to teachers to useful programmes for trainers. This will also offer access to trainers of industries and organisations. Use of electronic media will facilitate conduct of some programmes under distance learning (DL) mode to increase the reach of TTTIs to the society. TTTI's leadership is organising coordination meetings to work-out vision (what will be the desired scenario in the future) and mission (how to reach the desired scenario) statements based on the present and future needs of customers. TTTI will be changing from more restricted approach to more flexible and dynamic approach to take care of customer expectations and needs.

5

Corporate Distance Learning

Global competition will further intensify in the coming years as emerging South-east Asian countries join the developed countries in competing head-to-head with the United States. The challenge facing US corporations is how to prepare their workforce for effective participation in the skill-intensive industries that increasingly represent the backbone of the US economy. The success of US corporations in these new industries will depend to a greater extent on the relative skills of their workforce and to a lesser extent on the availability of natural resources and the cost of labour.

DISTANCE LEARNING CHALLENGES

Corporate management faces a number of business challenges, including the following:

- Upgrading the skills of corporate employees through corporate training programmes;
- Upgrading the skills of corporate employees through formal university education;
- Establishing closer electronic ties with customers;
- Developing products and services rapidly and responding quickly to customer needs; and
- Improving communications between upper management and employees.

DISTANCE LEARNING APPLICATIONS

The IDL (Interactive Distance Learning) solutions can play a significant role in addressing each of the issues identified in the introductory section. To address those challenges, telecom/datacom managers need to understand how the challenges translate into specific IDL communications systems, applications, and solutions. These links are necessary to support the following IDL applications:

- Corporate training;
- Intra-company collaborative learning and research;
- Inter-company collaborative learning and research;
- Remote university education;
- Executive communication; and
- Market research.

Blue-collar workers

One group of corporate employees that requires intensive training is blue-collar workers. Their training is necessary to increase productivity and to enhance their abilities to manage increasingly complex machines. According to experts in the field of corporate training, over 50 million US workers need to be retrained.

Workers need to acquire basic skills, including reading, writing, and computation, as well as interpersonal skills. Interpersonal skills are necessary because workers can no longer count on maintaining their jobs by performing repetitive jobs that are defined by rigid, work rules. Instead, workers need to learn how to be more adaptive to be able to perform multiple tasks in a flexible manufacturing environment. They also need to learn how to operate as part of a team, since the teaming model is increasingly replacing the older model, in which workers were assigned specific tasks that they performed repeatedly.

White-collar employees

The challenge of corporate (re)training also encompasses white-collar workers, who have to keep up with the latest developments in their fields. Technical functions, which represent about 80 per cent of the US workforce and receive about 30 per cent of the annual corporate training budget, have the most demanding training needs. For example, technical applications are advancing so rapidly that a person performing a technical function needs to be constantly retrained to keep up with the latest advances in the field. Product training is another important area of training for white-collar workers. In a competitive economy, corporations are racing to introduce new products and services. To be more effective, they need to speed the process and reduce the cost of disseminating information about new products to the sales force in the field. The need for such alternatives becomes more critical as (a) the size of the sales force increases; (b) the sales force is more distributed among multiple locations, which may be scattered throughout a state, the country, or the world; and (c) the rate of new- product introduction increases.

The alternative to direct face-to-face meetings could be one of several IDL technologies. Marketing and product managers play a vital role in the development and introduction of these products to salespeople in the field.

Problems with current corporate training

Despite the importance of training, the United States has the lowest percentage of spending on training compared advanced European nations and Japan. Considering the growing importance of human capital relative to the capital allocated to retooling, corporations need to find a better balance between the two outlets of capital expenditures.

Technology needs of corporate training

The technology requirements associated with corporate training differ from one function to another.

— Technical personnel are the most demanding in terms of the technology they need for corporate training. They value high-quality two-way video-conferencing solutions that can transmit quality video. Often they also need high-resolution still images related to the topic they are studying, which can range from CAD (Computer Aided Design) images for engineers to medical images for health services personnel.

— Marketing personnel may also be demanding in terms of the technology they need for product training. The quality of service required for product training is a function of the complexity of the product being introduced. If the topic of training is, for example, a new insurance product, the IDL solution may be as simple as audio conferencing. As the products become complex (e.g., technically-oriented products), marketing managers need to add the visual component to their conferencing systems.

- Administrative personnel, such as accountants, lawyers, and human resource managers, are less demanding in terms of their IDL technology requirements and may be satisfied with one-way video/one-way audio solutions.

Executive communication applications

Corporate management in a headquarters location needs to establish (distance learning) communications links with corporate employees located in branch offices to formulate, create and disseminate corporate policy and to support emergency communications.

Corporate policy communication

The financial success of corporations is increasingly dependent on the ability of the upper management to anticipate competitive moves, to rapidly formulate and implement effective responses to those moves, and to mobilise employees to assume responsibility in implementing those moves. To ensure the effective dissemination to and buy-in of employees, management needs to establish a continuing dialogue with as many employees as possible throughout the process of developing and implementing the company's strategic plans. That dialogue would accomplish two purposes: (1) to generate feedback from employees about planned changes, and (2) to create consensus among employees to ensure that the strategies are implemented, not undermined because of the lack of employee support or understanding.

The keys to the effectiveness of these interactions are *speed, cost, interactivity,* and *reach*. Reach refers to the number of employees that can be contacted simultaneously by corporate management; interactivity is the ability of management to establish a two-way dialogue. Traditionally, managers have communicated their messages and requested feedback from employees through memoranda or through field visits to branch offices. Increasingly, managers rely on e-mail to reach employees in various locations, an approach that enables employees to respond to the messages. E-mail is being complemented by other telecommunications approaches, including video broadcasting.

Emergency communications

Corporate management needs to rapidly reach employees in case of emergencies to ensure that all employees are making a concerted effort to contain and diffuse a crisis with minimum damage to corporate profits and corporate reputation. Upper management is (or should be) seeking cost-effective IDL approaches. The type of conferencing technology may be a function of the products being sold.

Learning and research

Product introduction involves extensive interactions at various stages of product development among engineers, product designers, sales people, marketing researchers and managers, and R&D. A successful process of idea generation, product development, and implementation must be rapid, interactive, frequent, and inclusive of all the departments and functions involved. It also must be a learning process in which all participants learn from each other and build on each other's knowledge and ideas. Of all the applications that have been explored in this chapter, this IDL application is probably the most demanding because it requires not only the visual/audio component of a conferencing solution but also the data component.

Remote university education

Educational services include university degrees offered to employees during after-work hours, as well as continuing education. The corporate approach of meeting employees' needs for university courses and degree has been for employees to attend classes on campus. One shortcoming of this traditional approach is that many employees are unable to attend courses on university campuses due to physical distance.

Telecommuting distance learning application

Telecommuting is a growing corporate phenomenon that enables employees to work at home several times a week while retaining electronic communications links with the corporate office.

According to industry figures, between four million and eight million corporate US employees have worked at least eight hours per week from home as company employees and during business hours in recent years. Employees are increasingly requesting permission to telecommute as a way to improve productivity, and at the same time spend more time with their families by reducing time on the road.

Telecommuting saves money that employees spend on purchasing, maintaining, and fuelling a car, on public transportation, and on summer and winter clothes. Employees believe that as telecommuters they can be more productive because they can work with no interruptions from co-workers, in more comfortable surroundings, with reduced exposure to air pollution, particularly in major urban areas, and without the stress associated with commuting. Faced with increasing US and international competition, regulatory pressures from federal, state, and local government, and increasing demands from their employees, employers are now developing and implementing telecommuting programmes.

Productivity gains can be achieved because telecommuters can work longer hours (6 to 10 hours per week) in view of eliminated commuting. Telecommuters also have improved work quality due to easier management of distractions and stronger work incentives resulting from a greater sense of being in control. Employers are also developing and implementing telecommuting programmes to reduce the costs of recruiting, relocation, and health insurance; to lower overhead costs associated with office space by making double use of desks; to reduce retraining costs resulting from employee turnover; and to recover from disasters more quickly by establishing communications links between corporate offices, including corporate data centre locations, and the telecommuters' homes.

Other sources of cost savings to employers include reduction in travel costs and reduction in penalties associated with non-compliance with government air quality mandates, which translates into fewer costs associated with penalty fees. Telecommuting also enables employers to reduce costs by utilising untapped resources, including over 30 million disabled individuals who could join the workforce through solutions such as telecommuting.

The needs of telecommuters related to IDL are similar to those of their corporate colleagues working out of corporate offices. These needs include the following:

a) *Collaborative research and education* with their corporate colleagues operating at corporate offices. Telecommuters would like to establish computer conferencing sessions with supervisors, partners, and technical colleagues on short notice to collaborate in the process of developing new products. For example, team members residing in different locations may be working on a design problem; establishment of a voice and data conference session would allow all the participants to view product illustrations, specifications, and graphics on their computer screens.

b) Market research is needed to compete more effectively, for which marketing managers need to develop product features that meet customer needs. To keep in touch with their customers, many marketing managers conduct primary research, that is, gather information directly from customers. Traditionally, primary research has involved face-to-face meetings, telephone interviews, survey questionnaires, and focus groups. Each of these approaches has its limitations. For important customers, corporations may want to use complementary video-conferencing, which can be considered a distance learning application.

NEEDS OF CORPORATE MANAGERS

In selecting corporate IDL solutions, telecom/datacom managers should take into account the following factors:

Geographic coverage

Telecom/datacom managers seek application solutions that support the geographic range of their end users. This range may encompass LANs, MANs, and WANs.

Range of applications and functions supported

Telecom/datacom managers are concerned about a larger set of applications than those that are important to individual IDL receivers and providers. By definition, the needs of the entire organisation have to be taken into account.

Support for installed base

In selecting a distance learning solution, telecom/datacom managers seek a distance learning solution that enables them to overlay the IDL solution on their existing network infrastructure. The corporate infrastructure may include the following elements:

- *A voice networking environment*, supported by a PBX or centrex and extended over MANs or WANs through either private lines or a public switched network system. Private lines for voice applications are increasingly being replaced by virtual private solutions and by circuit switched services.
- *Legacy systems, including System network architecture* (SNA) systems inter-connect hosts in one location (usually the headquarters location) with terminals in the same location or in other locations. Traditionally, hosts and terminals were inter-connected through X.25 networks and private lines. Increasingly, these locations are inter-connected through, a frame relay network.
- A *client/server environment. Clients* and servers may be in the same location and inter-connected across LANs, such as Ethernet, token ring, and fibre distributed data interface (FDDI), or they may be remotely located. Until recently, client/server environments were extended over WANs through private line services. Now, FRS, ATM, and NMLIS are replacing private lines as WANs of choice to inter-connect these environments.
- Satellite networks. This technology is used widely for high-quality video distribution.

Access methods and speeds

Telecom/datacom managers need different access methods and speeds to support these applications. Their requirements are shaped by the installed base as well as by cost factors. The range of access methods and speeds may differ from one company to another.

Ease of use and administration

Telecom/datacom managers value application solutions that are easy for IDL receivers and providers and other corporate end users to use.

Low cost

Telecom/datacom managers should take into account a number of elements in measuring the total cost associated with a new application solution, including the cost of acquisition, implementation, maintenance, and training.

Intra-company versus inter-company communications

The appropriateness of the application solution may depend on the extent of the needs of telecom/datacom managers for inter-company versus intra-company communications.

DISTANCE LEARNING SOLUTIONS

A fair portion of that market can be served by wide range of IDL applications solutions which include the following:

- Dedicated institutional IDL systems, which can be further classified, in increasing order of complexity and sophistication, as one-way video/two way audio, two-way video/two-way audio, and n-way video/n-way audio with continuous presence;
- Groupware; and
- Internet.

The following descriptions of these solutions assess to what extent each solution can support IDL applications.

The one-way video/two-way audio solution

This IDL solution is also referred to as "business TV". Business TV is based predominantly on satellite technology.

Two satellite approaches are available:

- Traditional satellite links, in which a transponder is dedicated to video; and
- VSAT technology, which is less expensive than traditional satellite approaches but more limited.

Traditional satellite services

Commercial satellite communications began in the mid-1960s. Satellites now carry voice, data, and video traffic. Satellite communications offer certain advantages, such as broadcast capabilities and mobility. The technology, however, is under pressure from other high-quality transmission media that support broadband communications, particularly fibre optics.

Communications satellites act as relay stations in space for radio, telephone, and broadcast communications. Commercial communications satellites lie in the geostationary (geosynchronous) orbit at approximately 36,000 km (22,320 miles) over the equator. Small variations in the mass and the shape of the earth affect a satellite's orbit, requiring that it be "repositioned" under spacecraft power to regain the proper position. More than 120 communications satellites occupy the 165,000-mile circumference of the geosynchronous orbit.

The characteristics of geosynchronous satellites include the following:

- Broad earth coverage (corresponding to approximately one-third of the earth);
- Orbital period of 24 hours; and
- Round-trip delay of approximately 500 ms for half-duplex communication.

Most satellite antennas must point to a predetermined area of coverage throughout the entire life of the satellite. The method used to control the antenna depends on whether the satellite is spin-stabilised or three-axis-stabilised. Spin-stabilised satellites are stabilised by the induced rotation of the satellite according to the principle of the gyroscopic effect.

The antenna is mounted on a counter-rotated platform so that it appears to be stationary in reference to the earth's surface. In a three-axis-stabilised satellite, the antenna is mounted on a limited-motion gimbal, giving it flexibility in pointing; this antenna system requires a more complex control system than the spin-stabilised system.

However, three-axis stabilised satellites have larger solar cell arrays compared to the surface of a spin-stabilised satellite, allowing them to have more operational power. Satellites that are not in the geosynchronous orbit require earth stations with movable antennas to track them; such is not the case for geosynchronous satellites.

In the United States, which is the largest user of satellite resources, several organisations provide a spectrum of communications services over geostationary satellites operating around 4 and 6 GHz and around 12 and 14 GHz. Additional satellites in this frequency band are precluded by the lack of suitable orbit slots; hence, consideration is being given to higher-frequency operation (around 20 to 30 GHz).

The advantages of satellites include the following:

— The superiority of satellites for point-to-multipoint transmission makes them ideal for geographically dispersed broadcast TV (which requires transmission from a single location to many affiliate stations or to satellite dishes on roofs) and for private networks (e.g., teleconferencing and communications between corporate headquarters and branch locations).

— Satellite antennas are relatively easy to install and are even mobile, when installed on a small truck, and enable any ground station to become a network node. That makes satellites ideal for reaching remote or thinly populated areas where fibre optics cables would not be economically feasible. Fibre optics systems also require the establishment of a right-of-way for the cable to be laid, which can be difficult and costly.

— Satellites can be easily reconfigured while in orbit to cover different geographical areas.

— Total network failures are unlikely with satellite systems, except for catastrophic failure of the satellite itself. Storm damage to individual antennas will not affect the rest of the network.

Some factors that affect the applications of the technology to business communications include orbital spacing (e.g., only about 60 degrees of total equatorial orbit space are suitable for domestic satellite use), earth station cost, antenna size, transponder power, and security. Difficulties in the late 1980s in delivering payloads into space have affected the availability of capacity for a number of years.

Additionally, satellite orbits are close to being fully utilised. Other limitations include a lack of intrinsic security and propagation delays. None the less, many communication applications have emerged, including distance learning. What follows is a partial list of companies that use full-motion TV satellite-based technology for IDL.

VSAT Technology

VSAT systems were deployed in relatively large numbers in the mid-1980s to early 1990s. Now with the plethora of new communications alternatives, it is not clear if the investment in hundreds of customer-owned satellite antennae is cost- justified with a reasonably short payback period. One of the technological advances in the space segment has been increased transponder power, resulting in improved signal strength. This implies an acceptable signal quality even when smaller and less expensive earth stations are used compared to traditional satellite systems.

The phrase 'very small aperture terminal' refers to the size of the antenna dish, which is usually 1.2m or 1.8m in diameter. The network topology is a star. Equipment prices have dropped to the point where a 1.2-m transmit/receive antenna now costs around $ 5,000. During the past few years, there has been a general switch from C band to Ku band, providing even more signal directionality and increased effective isotropically radiated power.

The FCC allocated the frequencies from 11.7 to 12.2 GHz and from 14.0 to 14.5 GHz—portions of what is commonly referred to as the Ku band—for primary use by fixed-satellite communications. With Ku band, some adjustment for rain attenuation can be made by using a stronger signal. Users of VSAT networks can take advantage of the inherently broadcast nature of satellite communications. They can add or move sites within the footprint without concern for signal loss or increased monthly charges, since the signal is being continuously beamed across an entire area; however, moving does incur installation charges. VSAT solutions are ideal for networks that have a star configuration, where a host computer site communicates with a number of geographically dispersed remote sites. As a rule, the outbound volume should be greater than the inbound volume.

However, other configurations can be accommodated as well. VSAT applications are primarily for data and include point-of-sale, credit authorisation, inventory control, and remote processing. In the early 1990s, video applications accounted for about 20 per cent of the total VSAT traffic, and voice represented about 5 per cent

A VSAT network consists of three major elements:

— The master earth station (MES);

— A number of remote VSAT earth stations; and

— A host computer site.

The large MES transmits a powerful signal to the satellite, so that the receiving VSATs can capture a high-quality signal. The transmit signal of, the VSATs is relatively low powered, and the MES is needed to receive it, especially in a point-to-point network, where the VSATs are communicating with each other.

The MES antenna is generally from 5m to about 6m in diameter. The MES must be designed specifically to support the type of equipment in use at the customer's host site. Most vendors' systems are designed to accommodate IBM SNA-based equipment, LANs, or both and are plug compatibles. The MES performs a variety of essential functions, including transponder monitoring and host interfacing. In addition to its antenna dish, the hub earth station consists of RF/IF electronics, the network switching system, and a network management computer. Whether the MES for a network is shared among several organisations or is dedicated to one organisation is a key question.

The average network payback period for a network with a dedicated MES is estimated to be about five years, and it may be as short as one year in some cases. The cost of the hub-up to $1 million places a fully private SAT network out of the reach of most organisations. However, potential users will have access to full-service, shared-hub network offerings from satellite carriers and others. The number of sites required to justify the choice of VSAT is variable. The vendors offering shared-hub network services claim there is no minimum number of sites (the emergence of shared-hub services offered by carriers is an important element in the size of the market).

The VSAT video solution offers several advantages to corporations:

— *Low monthly charges*. VSAT can help companies overcome the burden of local access charges. It can be cheaper than a regular transponder.
— *Access methods and speeds*. VSAT supports speeds up of DS1; hence, it supports H.261/H.262-video (i.e., video-conferencing quality), which is generally adequate for corporate users.
— *Range of applications supported*. VSAT networks can support the following IDL applications: corporate training, remote university education, and executive communication.
— *Support for installed base*. It requires minimum changes `to corporate telecommunications infrastructure.
— *Geographic coverage*. VSAT can cover a wide geographic area, for example, major regions of the country or the entire country.
— *Ease of expansion*. Users can add a capacity to a network by requesting additional transponder bandwidth. Remote satellite antennae have to be installed. Generally, additional locations can be brought on line within a matter of days.

- *Intra-company versus inter-company communications.* VSAT technology is appropriate for both inter-company and intra-company communications.

The VSAT solution does have a number of limitations:

- *Inadequate support* for some IDL applications, including intra-company collaborative learning and research, inter-company collaborative learning and research, and market research. The VSAT solution cannot support these applications adequately because interactivity is limited to audio communications.
- *Increasing transponder cost.* The cost will likely be on the rise since many currently orbiting satellites are approaching the end of their useful lives and will not be replaced until the payload backlog is reduced.
- *Delay.* While VSAT is adequate for business TV, the half-second delay associated with VSAT transmission makes this technology less than optimal for two-way video/two-way audio communications with high interactivity.
- *Security.* Businesses need to encrypt the messages prior to transmission.

Two-way video-conferencing systems

Terrestrially based video systems fall into two categories:

- Full-motion analog (6 MHz) or digital (45 Mbps) video; and
- DS1 and $n \times 64$ Kbps video-conferencing systems.

Video-conferencing systems (e.g., those using $n \times 64$ Kbps digital services) are currently used by more than 50 per cent of all Fortune 1000 companies. The largest users of video-conferencing are medical and educational institutions, with over 28 per cent of the video-conferencing installed base, followed by wholesale retail with 24 per cent. Corporations rely on video-conferencing systems to support the corporate training. For example, in the retail industry, video-conferencing systems are used to broadcast information on merchandise and new products to dispersed store locations.

The timely delivery of this information provides store managers with several benefits, including the ability to be more responsive to the marketplace, the ability to reduce store costs associated with carrying unwanted inventory, and the elimination of discount sales to dispose of obsolete merchandise. In the automotive industry, video-conferencing is used to keep car dealers informed of price changes, incentive programmes, spare parts availability, and maintenance procedures.

Benefits of two-way video-conferencing

The two-way video-conferencing solution to corporate distance learning offers several advantages to corporations:

- *Access methods and speeds.* A wide range of networking solutions can support the two-way video-conferencing solution.
- *Range of applications supported.* The two-way video-conferencing solution can support all the IDL applications: corporate training, remote university education, executive communication, intra-company collaborative learning and research, inter-company collaborative learning and research, and market research. In the case of the collaborative research/learning application, desktop solutions are superior to room-to-room solutions.
- *Support for installed base.* This solution requires minimum changes to the corporate telecommunications infrastructure.
- *Geographic coverage.* This solution can cover a wide geographic area.
- *Intra-company versus inter-company communications.* This solution is appropriate for both inter-company and intra-company communications.

The two-way video-conferencing solution, however, has one major limitation: cost. The cost factors differ, depending on the networking solution selected, the number of participants, and whether the solution is implemented room to room or desk to desk. Multicasting is more difficult with a terrestrially based system than with a satellite-based system.

Internet

The internet can support corporate needs for several IDL applications, including intra-company collaborative learning and research, inter-company collaborative learning and research, and corporate training.

The internet supports corporate IDL applications through the following services:

- E-mail;
- File transfer;
- Host-to-host communications;
- Directory services;
- Online library catalogue; and
- Electronic whiteboards.

The internet offers corporations the following IDL benefits:

- *Support by network service providers*. Access to the internet is increasingly supported not only by the traditional internet providers but also the AAPs, the LECs, and the IXCs.
- *A high-performance backbone*. The NSF backbone is migrating from a DS3 platform to a higher-performance network based on ATM and SONET.
- *An expanding range of applications*. The internet can support collaborative learning and research applications (this was the original intent of the internet).
- *Affordability*. The internet remains one of the least costly approaches to providing inter-connection.
- *Extensive information resources*. This represents another major source of strength of the internet as an application solution to the distance learners. Through the internet, the IDL community can access hundreds of libraries around the world, as well as library catalogue and full-text delivery services.
- *Ease of use*. New services, such as WWW, make the internet easier to access and to use, extending the use of the internet beyond the corporate technical functions to encompass, for example, the marketing functions.

The internet, however, cannot be considered as a complete IDL solution for the following reasons:

— *No guaranteed performance.* The IDL community needs to take into account that they cannot -be guaranteed a given throughput across the internet nor a consistent reliability level. That is because the internet, while serving thousands of organisations and millions of individuals, lacks any mechanism for reserving bandwidth. In addition, the internet is made up of many networks. Hence, the establishment of common reliability levels requires complex interactions among a large number of internet providers.

— *Lack of extensive antiviral software.* Internet e-mail and downloaded files have been known to contain viruses. These viruses cannot be eliminated without the availability of antiviral software on every machine on the network.

— *Junk e-mail.* Corporations connected to the internet can be flooded with useless and unwanted e-mail. Junk mail is particularly problematic to corporations, because their employees may spend valuable time reading the junk mail. Junk e-mail also consumes valuable disk space.

— *Security issues.* Probably the most important concern of the internet is its security limitations. Several internet security violations have occurred lately. The security limitation of the internet restricts the usefulness of the internet to interorganisational communications, including those associated with IDL solutions. For example, as long as security is a major concern, corporations cannot rely on the internet to deliver corporate training courses, even when two-way videoconferencing over the internet becomes more widely available.

Groupware

Groupware is an emerging data-oriented corporate IDL solution that can provide corporations with a private alternative to the internet. Groupware refers to software that supports at least one of the following IDL applications:

- Electronic messaging;
- Data conferencing; and
- Last messaging gateways.

Groupware offers IDL receivers and providers and other corporate employees several benefits:

- *Low cost.* In implementing groupware, telecom/datacom managers incur a non-recurring cost. This cost is on either a user or a server basis.
- *Multiple applications.* Groupware supports multiple applications, including collaborative learning and research.
- *Ease of use.* Multifunctional groupware solutions are based on GUIs, which makes it easy to use by IDL receivers and providers and other corporate employers.
- *Security.* As a private solution, groupware provides a more secure, solution for intra-company communications than the internet.
- *Training and consulting.* The leading providers of multifunctional groupware provide their buyers with training or consulting as part of their product package.

While groupware offer corporations several benefits, telecom/datacom managers need to consider that groupware is predominantly implemented as a private application solution. They also need to consider the cost of selecting, implementing, and upgrading the groupware solution.

CORPORATE NETWORKING SOLUTIONS

Currently, there are several distance networking solutions that can meet at least some of the telecom/datacom managers' requirements and that can support some of the IDL application solutions described in the previous section. These solutions include:

- Private DS1 lines;
- Switched/dialup services;
- SMDS;
- FRS; and
- ATM/CRS.

These solutions include dialup analog services and ISDN. For each solution, a brief description is provided and its key strengths and limitations relative to IDL applications are highlighted.

Private lines

A private line is a dedicated service that operates at DS1, DS3, and SONET speeds. This service provides a communication link between two locations through the establishment of a physical connection. Private lines are currently widely available in the United States and are offered by LECs, AAPs, and IXCs. As an IDL solution, the private DS1/DS3 solution provides a corporation with several benefits, including the following:

- *Support for IDL application solutions.* Private lines can support most IDL application solutions, including one-way video/two-way audio, two-way video/two-way audio, groupware, and the internet.
- *Support for installed base.* Private networks became an integral part of corporate networks in the 1980s. The introduction or expansion of IDL solutions to a corporate networking environment may simply mean the allocation of a number of spare private-line channels to distance learning application solutions or the expansion of the installed base of private lines.
- *Security.* Private lines are perceived by telecom/datacom managers to be secure, since they are dedicated to individual customers. An increasing number of these lines are carried over fibre facilities.
- *Adequate bandwidth.* DS1 private lines provide corporations with adequate bandwidth. This bandwidth can be subdivided into multiple subchannels. Some of these channels can be dedicated to an IDL solution, while other subchannels can be used for other corporate applications. Each channel or group of channels can support various types of traffic, including voice, signalling, data, and video.
- *An established supply structure.* Private DS1 line services are established services. They are widely

supported by LECs, IXCs, and AAPs. In addition, the increasing competition is driving down costs and making the service even more appealing.

— *Reliability*. *D*S1 private lines are reliable and proven. Information transport in dedicated bandwidth time slots guarantees throughput with no lost packets or processor bottlenecks.

— *Scalability*. DS1 private lines are scalable (e.g., DS3 lines), allowing for flexible network configuration, particularly for small networks.

Typically the corporate telecom/datacom manager allocates some of this bandwidth to data applications (both legacy mainframe traffic and legacy LAN traffic), voice applications (PBXs), and video. Private networking solutions are not, however, optimal in all situations. One of the drawbacks is that DS1 economics become less appealing to telecom/datacom managers as the number of corporate locations requiring inter-connection increases.

TDM-based private-line solutions are also bandwidth inefficient because they allocate bandwidth to devices that have nothing to send. Another shortcoming of DS1 private lines is that as private networking solutions they cannot support the IDL networking links of corporations with universities, high schools, suppliers, partners, customers, and telecommuters. An example of a private line-based video-conferencing network is that offered by SBC. This service connects corporate locations in Oklahoma with IDL providers, such as Oklahoma State University.

Switched/dialup services

Switched/dialup digital services are circuit switched-based services that support speeds ranging from 56 Kbps to DS3 and support voice, video, and data traffic. With private lines, corporate participants need multiple dedicated lines to establish connections with multiple locations; with switched/dialup service, corporate participants need only one access line per required connection; with a network resident bridge, only one line per location is needed. To establish a connection with other locations, a corporate participant dials a number (call setup is based on the North American dialling plan). When the circuit switch receives the call request, a circuit is established for the duration of the call. This circuit is taken down as soon as the call is completed.

Switched/dialup services offer corporate participants several advantages over private lines:

- *Support for IDL application solutions.* Switched/dialup services can support most IDL application solutions, particularly at the higher speeds, including one-way video/two-way audio, two-way video/two-way audio, and the internet.
- *Cost reduction.* Switched/dialup services could be more economical than dedicated DS1 lines, particularly when there are many sites to be inter-connected, because with switched/dialup services each corporate site requires only one connection to reach all other destinations when a bridge is used (otherwise, multiple access lines are required). The economics depend on usage levels; at low usage, dialup lines are cheaper.
- *Extensive bandwidth capabilities.* Switched/dialup services provide the telecom/datacom manager with bandwidth capabilities that range from 56 Kbps to 45 Mbps. However, a set of dedicated access lines is required.
- *Flexibility.* Switched/dialup services are flexible because they enable telecom/datacom managers to include additional locations in their corporate networks without having to justify the expense of an end-to-end dedicated line.
- *Migration capabilities.* Switched/dialup services provide corporate participants with a migration path to more advanced switched services such as FRS and CRS.

While switched/dialup services can provide a corporation' with several benefits, they have several limitations:

- They are not widely available yet, particularly at the higher speeds (this situation may change in the next few years, because RBOCs are increasingly deploying circuit switched services at DS1 speeds).

— As a circuit-switched technology, switched/dialup services have a relatively long call-setup time 13 seconds), although that should not be a problem for any IDL applications except data distribution.

— Switched/dialup services cannot support LAN interconnection applications, such as groupware, in the most effective manner, because bridges can be unstable when inter-connected through switched/dialup services.

SMDS

One of these access speeds can be supported by a DS1 access line, while the other speeds (4 Mbps, 10 Mbps, 16 Mbps, 25 Mbps, and 34 Mbps) can be obtained by using a portion of a DS3 line. SMDS is also available at 64 Kbps. SMDS offers low delay (5-10 ms for a DS3-DS3 link), high throughput (95 per cent of packets are delivered in less than 20 ms), low error rates, high reliability, and availability (99.9 per cent). SMDS addressing scheme complies with ITU-T E.164 plan for ISDN/BISDN "telephone numbers", providing end users with transition to ATM, at least in terms of this feature.

SMDS has several service capabilities, including multiple addresses per interface, and authentication of address in each packet. An SMDS customer can choose a list of addresses to communicate with; all other addresses are blocked. In addition to its addressing capabilities, SMDS enables corporations to establish logical private networks, which could be used by corporations to establish connectivity with a select number of corporate locations, suppliers, or customers.

SMDS also has multicasting capabilities, which are similar to the broadcast/multicast capabilities of LANs. These capabilities are useful for address resolution, router updates, and resource discovery. Corporations can deploy SMDS either as a new service or as a replacement of private lines. To deploy SMDS, a telecom/datacom manager needs to order the service from the local exchange carrier, install a DS1 or DS3 SMDS access line from the desired location to the service office of the local exchange carrier, purchase a router or an SMDS upgrade for an existing router, and install a DSU/CSU on the access line. SMDS is principally used for data.

SMDS provides corporations with several benefits, including the following:

— *Cost reduction.* SMDS could be more economical than dedicated DS1 lines, particularly when there are many sites to be inter-connected, because with SMDS each corporate site requires only one access connection to reach all other destinations. SMDS can also reduce corporate administrative costs if network! Connections cannot be predicted in advance, or if those connections are constantly changing (of course, each potential remote location needs to have an access line). SMDS is also more economical for small organisations that have considerable data communications needs but cannot justify the expense of building a private network, SMDS could also be viewed as an economical service, because it provides a relatively graceful migration path to ATM technology.

— *Support for bursty data applications.* SMDS is well suited for corporations that want to implement data-oriented IDL solutions, such as groupware and the internet.

— *Extensive bandwidth capabilities.* SMDS provides the telecom/datacom manager with a choice of access classes, enabling the manager to start at a lower bandwidth level and then migrate the network to a higher access class as the communications needs of the institution warrant the upgrade.

— *Flexibility.* SMDS is flexible because it enables telecom/datacom managers to include corporations in their corporate networks that do not justify the expense of a dedicated line.

— *Security.* SMDS has several appealing security features, enabling telecom/datacom managers to establish virtual private networks. Addresses can be screened so that only authorised destinations can receive data, and only authorised sources can send data.

While SMDS can provide a corporation with several benefits, it has several shortcomings: It supports only packet data traffic, and it cannot support voice and real-time video applications. Consequently, SMDS cannot support a number of IDL solutions, including one-way video/two-way audio and two-way video/two-way audio.

Frame Relay Solutions (FRS)

Frame relay networks provide another data communications alternative for corporations. FRS is a (mostly) data-only, connection-oriented frame-transport service over assigned virtual connections. These virtual connections, which supported through statistical multiplexing techniques, can be either permanent or switched. The FRS available on the market at press time was PVC based. A PVC connection is usually established when the service is provisioned at subscription time, eliminating the need for user-to-network signalling. FRS supports access speeds of 56 Kbps, n × 64 Kbps, and 1.544 Mbps. A frame relay network is based on ANSI standards, including T1.606, which specifies user-to-network interface requirements; ANSI T1.617 annex D, which specifies network management functions; and ANSI T1.618-1991 (LAP-F Core), which operates at the lower sublayer of the data link layer and is based on the core subset of T1.602 (LAP-D).

The frame relay data transfer protocol defined in Tl.618/LAP-F Core is intended to support multiple simultaneous end-user protocols within a single physical channel, since, above layer 2, this protocol is transparent. As a result, most existing protocols (e.g., TCP/IP) can ride over frame relay transparently to the end devices.

Frame relay can be implemented as either a private or a public solution. Frame relay can be implemented as a private networking solution by either (a) purchasing routers (or frame relay software additions to existing routers) and establishing point-to-point connections among those routers, or (b) using a customer-owned frame relay nodal processor (or a software upgrade to an existing packet switches or multiplexers), which is basically a frame relay switch.

FRS provides corporations with several benefits, including the following:

- *Economic benefits.* FRS offers a more economical networking solution than TDM-based DS1 lines because it is based on statistical multiplexing techniques. In the long term, FRS could also be viewed as an economic service, because it provides a migration path to ATM in the sense that it gets the organisation on a packet-based paradigm.
- *Support for bursty data traffic.* FRS is well suited for specifically supporting data-based IDL application solutions, such as groupware and internet access.
- *Availability.* FRS is widely available and is currently supported by IXCs, LECs, and RBOCs. FRS is also increasingly supported by the AAPs, such as Teleport Communications Group.

While FRS can provide a corporation with several benefits, it has a number of shortcomings, including:

- *Lack of support for isochronous traffic.* FRS supports only bursty packet data traffic. It cannot effectively support voice and real-time video applications. Consequently, FRS cannot support several IDL application solutions, including one-way video/two-way audio or two-way video/two-way audio.
- *Complex administration.* FRS requires careful administration for large PVC networks because the network administrator must define the connections for everyone on the network, including users who are added or changed. Network administration is becoming an increasingly important issue for large corporations, which are witnessing two conflicting but coterminous trends: network consolidation used as a cost-cutting measure and network expansion as a result of mergers and acquisitions or a reach for complete distributed computing (e.g., client/server).
- *Bandwidth limitations.* PVC FRS offerings support speeds of up to DS1 (El speeds in Europe). As result, frame relay may not be able to support the bandwidth

requirements of technical IDL receivers and providers, for example, quality video.

- *Transmission delays.* FRS, which transmits information in relatively small data units, has slightly higher end-to-end delay compared to private lines of the same bandwidth because of the need to store and process packet headers and trailers. FRS are also prone to queuing delays because multiple sources are competing for a given trunk circuit.
- *Packet loss.* Higher layer protocols have to recover lost data.

ATM Networking

ATM is a high-bandwidth low-delay switching and multiplexing communication technology that supports both LAN and WAN communications. To be exact, ATM refers to the network platform, while CRS refers to the actual service obtainable over an ATM platform. It is the general industry consensus that ATM is the service of choice for multimedia and other high-capacity interactive video-based applications. For readers familiar with the operation of a protocol stack, it is simply a matter of realising what functional partitioning has been instituted by the designers of ATM and what are the peer entities in the user's equipment and in the network.

The cell relay protocols approximately correspond to the functionality of the medium-access control layer of a traditional LAN but with the following differences: random access is not utilised, channel sharing is done differently, and the underlying media may be different. Connections in an ATM network support both circuit mode and packet mode services of a single media and/or mixed-media and multimedia. Two remotely located corporate multimedia or video-based devices required to communicate over an ATM network can establish one or more bidirectional virtual (i.e., not hard-wired or dedicated) connections between them. That connection is identified by each user by an appropriate identifier.

Once such a basic connection is established, user devices can utilise the virtual, connection-oriented channel for specific communication tasks. Each active channel has an associated bandwidth negotiated with the network at connection set-up time.

The transfer capacity at the user network interface (UNI) is 155.52 Mbps; other interfaces are also being contemplated in the United States at the DS1 (1.544 Mbps) and DS3 (44.736 Mbps) rates. The ATM architecture utilises a logical protocol model to describe the functionality it supports. The ATM logical model is composed of a user plane, a control plane, and a management plane.

The user plane, with its layered structure, supports user information transfer. The control plane also has a layered architecture and supports the call control and connection functions; it deals with the signalling necessary to set up, supervise, and release connections. The management plane provides network supervision functions. It provides two types of functions: layer management and plane management. Plane management performs management functions related to a system as a whole and provides coordination among all planes.

Layer management performs management functions relating to resources and parameters residing in its protocol entities. In the user plane, the access protocol in the user equipment L consists of a physical layer at the lowest level and of an ATM layer over it that provide information transfer for all services. Above the ATM layer, the ATM adaptation layer (AAL) provides service-dependent functions to the layer above the AAL. TCP/IP may continue to be used by users' PCs and hosts (note that AALs usually only go as high as the data link layer). There are currently three AAL protocols: AAL 1, AAL 3/4, and AAL 5.

The service data units reaching the AAL consist of user information coming down the protocol stack, for example, from a TCP/IP stack or from a video codec; the information is segmented or cellularised by AAL into the 53-octet cells, so that they can be efficiently shipped through the network. For video and/or multimedia applications, AAL 1 (supporting CBR) can be employed by the user equipment; more recently, however, many have also advocated the use of AAL 15 for video. The AAL enhances the services provided by the ATM layer to support the functions required by the next-higher layer.

The AAL-specific information is nested in the information field of the ATM cell. To minimise the number of AAL protocols, a service classification was defined in the late 1980s based on the following three parameters: timing relation between source and destination (required or not required); bit rate (constant or variable); and connection mode (connection oriented or connectionless). Five classes of applications were then defined, as follows:

- *Class A*: Timing required, bit rate constant, connection oriented;
- *Class B*: Timing required, bit rate variable, connection oriented;
- *Class C*: Timing not required, bit rate variable, connection oriented;
- *Class D*: Timing not required, bit rate variable, connectionless;
- *Class X*: There are no restrictions (bit rate variable, connection oriented, or connectionless).

AAL 1 is used in conjunction with Class A service. A network supporting pure CRS, namely, the orderly, reliable, expeditious, high-throughput movement of user cells from an origination interface to a destination interface, supports Class X applications. CRS can be used in a variety of ways to support multimedia and video-based applications. In supporting multimedia applications, several issues depend on whether one uses multiple "single-media" connections (performing multiplexing at the ATM layer) or a single multimedia connection (performing media multiplexing above the ATM layer).

Some may contemplate using a single VBR cell relay connection for multimedia; here all media multiplexing is done by the application, using proprietary protocols at the AAL layer running over a network providing pure CRS. Another approach is to do multiplexing at the ATM layer, enabling the carrier to provide desirable value-added features.

Satellite transmission supports multipoint very well. However, terrestrial networks do not (yet) support that requirement in an effective manner. This fact has given impetus to the development of ATM/cell relay service: Point-to-multipoint and multipoint-to-multipoint connectivity will be supported as a key service feature.

ATM/CRS can provide corporations with several benefits, including the following

— *Support for data, voice, video, and multimedia traffic.* CRS provides corporations with the versatility and flexibility of fixed-length cells, making the service well-suited for all IDL solutions because of the low latency incurred in switching.

— *Economic benefits. CRS* offers higher transmission speeds than SMDS and FRS. It is also more economical than TDM-based lines because a single access line is required to establish communications links between corporate locations; with private lines, multiple access lines are required.

While CRS can provide a corporation with several benefits, CRS based on PVCs has one shortcoming: As a PVC service, CRS requires careful administration for large networks because the network administrator must define the connections for everyone on the network. SVC services will be added in the 1996-97 time frame.

Dialup solutions

Analog dialup solutions can support the needs of corporate telecommuters for remote university education. The Virtual College is an electronic learning environment for the efficient production and delivery of a wide range of high-quality business and technical courses. NYU's Virtual College and its online educational network are designed to meet these expanding training needs in an efficient and effective fashion.

The programme employs Lotus Notes software. Lotus Notes is a group communications programme (groupware) giving people who work together an electronic environment within which to create, access, and share information, using networked personal computers. Lotus Notes support such business applications as computer conferencing, information distribution, status reporting, project management, and electronic mail. To access a course offered by NYU's Virtual College, students must have an IBM-compatible PC with Microsoft Windows, a minimum of 2 MB of memory, 8 MB of available hard disk space, 1.44-MB 3.5-inch diskette drive, VGA monitor, and a 2,400- or 9,600-bps Hayes or Hayes- compatible modem.

ISDN

ISDN is a networking solution that can support the IDL needs of corporate employees through digital switched channels operating at speeds that fill the gap between traditional analog dialup and dedicated or switched DS1 lines. An example of an ISDN-based solution in which depicts a telecommuting/distance learning application. This solution provides the telecommuter with the ability to participate in a LAN-based screen-sharing conference that is taking place at a corporate location and to conduct a voice conference with the LAN participants as well.

The LAN-connected participants then establish screen-sharing sessions with the LAN conference bridge. The LAN conference bridge supports multipoint conferencing functions. As a result, the software on each participant's PC only needs to handle a point-to-point conference with the bridge. The telecommuter establishes a circuit-data connection to the communication server that makes the computer appear to be on the LAN.

The telecommuter then runs the same software as to set up a conference with the LAN conference bridge. The user also needs a PC or workstation equipped with an ISDN adapter, applications software compatible with software on the corporate site. This PC also has several B-channel capabilities, including simultaneous voice and circuit-data calling, support for two directory numbers and service profile ID, and support for rate adaptation for rates lower than 64 Kbps. On the corporate side, a communications server is required. This server must have application software compatible with communications software and with far end.

6

Internet and Distance Learning

The internet is an international network that connect over 60,000 domains worldwide. These domains serve over five million hosts. Traffic traversing the network at press time totalled 89 billion packets. The internet continues to grow rapidly. The mix of internet services and the relative traffic associated with each service continue to change as well. The services representing the majority of the traffic are FTP and WWW. The internet is a network infrastructure that was originally sponsored by a variety of federal agencies, including the NSF and the Advanced Research Project (ARPA).

The internet was intended to be a network that would facilitate communication and collaboration among researchers and educators in universities, government agencies, and industry. That, however, is no longer the exclusive role of the internet. Two growing roles of the internet are supporting electronic commerce and providing distance learning solutions to K-12 schools.

The internet supports an increasing number of services, some of which are described below.

1. *Logon services*: Logon services are offered by internet providers through two types of TCP/IP-based protocols: Telnet and Rlogin. The Telnet command has the advantage of being available on any host that allows remote login capability. Rlogin, a "Berkeley command", on the other hand, is not necessarily available on any host that allows remote login capability.

2. *E-mail*: E-mail is the most commonly used application on the internet. It is used by researchers in universities, government agencies, and corporations as part of their collaborative research process. It is supported by a wide range of delivery agents and delivery mechanisms.
3. *File transfer*: File transfer services is used to transfer files between internet hosts. Researchers at universities, corporations, and government agencies can use FTP to download as well as upload files to supercomputer centres. Anonymous FTP is a simple extension to the basic FTP protocol that enables students and researchers to create and share public archives with others on the internet.
4. *World Wide Web*: The WWW is a system that links information stored anywhere on the internet in a mesh of hyperlinks. These hyperlinks enable an educator or a student equipped with a suitable client (e.g., Mosaic, WinWeb, or Netscape) to navigate through a distributed information resource by simply following pointers from one hypermedia document to another. The hypermedia document may include text, sound, still images, and video. The WWW makes information resources on the internet accessible to users who are not experienced in UNIX-based commands.
5. *Electronic whiteboards*: Electronic whiteboards allow a speaker's notes to be shared in real time with viewers over a wide area. This tool makes the dialogue among researchers, educators, and students more interactive and more effective, enhancing the collaborative research and learning process.
6. *Video-conferencing*: Video-conferencing is an emerging internet service that enables K-12 students to establish low-end two-way video and audio connections with teachers and other students around the globe. This service originated as part of the Global Schoolhouse project. When available on a large scale, will provide a measurable benefit to K-12 students, because it provides them with international exposure.
7. *Directory services*: Directory services provide users with

the ability to locate information about other users, services, or service providers. Directory services are often divided into "white pages" and "yellow pages" services. The white pages service provides information about individual users, while the yellow pages service provides information about services and their providers.

8. *Gopher services*: Gopher services allow students and researchers to browse through information across the internet without having to log in or know in advance where to look for information. The Gopher system offers information as a simple hierarchic system of menus and files.

INTERNET CONNECTIONS

The internet connections are predominantly based on the TCP/IP stack of protocols. It will probably continue to be based on the TCP/IP protocol suite for the remainder of this decade, although some migration to IPv6 is possible. The IP layer is implemented on end systems as well as intermediary nodes. As a protocol IP is responsible for internet working multiple networks. These underlying networks may include LANs or WANs. TCP and user datagram protocol (UDP) are transport, protocols that are implemented on end systems to packetise all application-layer exchanges into appropriate protocol data units (PDUs) and to provide transport services suitable for the applications.

ACCESS TO THE INTERNET

The application-level solutions are available to users in accessing the internet at the logical level which are the following:

— *Time-sharing host solution*: The time-sharing host solution is more appropriate for the home and the K-12 networking environments. Through this solution, students and researchers can access the internet by obtaining an account on a time-sharing host that is located at the service provider's premises. In this case, the TCP/IP protocol stack resides on the time-sharing host. To access the time-sharing host, the user needs to have a workstation and a modem. To establish a connection with the time-sharing host, the researcher or educator needs to establish a dialup connection to the terminal server attached to the internet access provider's host. The dialup connection operates at speeds ranging from 2.4 Kbps to 14.4 Kbps. This dialup connection enables the user to dial into a terminal server that establishes a session with the time-sharing host. The host in turn establishes a connection across the internet with the target host. A file transfer then occurs from the target host to the time-sharing host; the file is downloaded to the user's workstation through a serial file transfer protocol such as Kermit or Xmodem.

— *Full TCP/IP connection*: The establishment of a full TCP/IP connection can be implemented in one of two ways: (a) a full TCP/IP suite may actually reside on the user's computer, or (b) a corporation may decide to establish an internet node on the corporate side.

The first full TCP/IP connection option enables the user to run the TCP/IP protocol applications on a PC, including e-mail, bulletin board (USENET), news programs, Telnet, FTP, and possibly Gopher. In that case, the user's workstation acts as a peer with other hosts on the internet, which enables the user to move files directly from and to a hard disc, instead of going through the two step process associated with accessing a time-sharing host. This approach also enables the user to access remote file servers, via network file systems (NFS) as apparent extensions to the file disk.

The full TCP/IP interconnection option requires establishment of an internet node on the corporate site. The user accesses the TCP/IP-based corporate host through a modem, a dialup line, and a serial line protocol.

Internet access speeds

The internet speed access methods can be divided into two categories: (a) low-speed access methods and (b) high-speed access methods.

- *Low-speed access methods* include dialup connections, X.25 dialup, toll-free dialup, and ISDN. Dialup connections are offered by the major internet service providers. The connections range in speed from 9. 6 Kbps to 28.8 Kbps. Toll-free dialup is offered by the major internet service providers. These connections also range in speed from 9.6 Kbps to 28.8 Kbps. ISDN access to the internet is increasingly available.
- *High-speed access methods* include two categories: fast packet services, such as SMDS, ATM, and FRS, and cable TV solutions, such as data/cable modems. The fast packet access solutions are offered by an increasing number of access service providers, while the data/cable solutions are offered by cable TV providers, such as TCI.

INTERNET SERVICE PROVIDERS

The internet services are offered by a number of providers, which can be categorised as national internet providers and regional/local internet providers.

- *National internet service* providers operate in multiple cities across the United States. These providers provide participating members with access (gateways) to other domestic and international networks. They include the Advanced Network and Services, Inc. (ANS), California Education and Research Federation Network (Cerfnet), Performance Systems International, UUNet Technologies, Inc., and Sprint Corporation.
- *Regional internet providers* include the San Francisco Bay Area Research Network (BARRNet), Committee on Institutional Cooperation Network (CICNet), and Southwestern States Network (WestNet), all of which operate in the western region of the United States. Global Enterprise Services, Inc./Northeast Regional Network (JvNCnet) and New England Academic and Research Network (NEARNET) operate in the North-east.

The number of the internet service providers is on the rise, because it represents an increasingly attractive business opportunity to network service providers and to hardware and software suppliers.

MULTIMEDIA OVER THE INTERNET

The Internet Engineering Task Force (EETF) standards are aimed at improving support for networked multimedia through bandwidth reservation and more effective use of multicast capabilities. Sending duplicate messages or setting up broadcast video-data collaboration conferences to multiple remote locations requires multicasting.

The IETF standard, distance vector multicast routing protocol (DVMRP) is a multicast routing algorithm used in the internet multicast backbone network to connectivity (e.g., video) to workstations that support IP multicast. DVMRP protocol operates by flooding all available routes. Protocols now under development are more efficient.

Protocol-independent multicast (PIM) uses "rendezvous points" for registration of the senders and receivers of multimedia multicast traffic. Being protocol independent, it works with any unicast routing protocol. A standard also under development is real-time transport protocol, which uses time stamps and content identification labels on multimedia data units to ensure reassembly at the receiving end.

Streaming II (ST-II) lets the originator control the bandwidth and latency in a multicast video-conference. A revised version, called ST-II+, allows for faster connection set-up and the ability of allowing receivers as well as senders to join a multicast group without needing a central administrative point; it was under development at press time.

The *Reservation protocol* (RSVP) offers a way to support bandwidth allocation on connectionless networks. It decentralises control over bandwidth allocations, letting each end system decide how much bandwidth is required to participate in a multimedia conference.

The NII will comprise a collection of infrastructures from various industry segments. Some observers (incorrectly) view the internet as lithe "true" NIL. They attribute their belief to the following strengths of the internet:

- *Support by network service providers*: Access to the internet is increasingly supported by not only the traditional internet providers but also the LECs and the IXCs.

— *Number of people reached*: Estimates of the number of people interconnected by the internet vary from 15 million to 20 million.

— *High-performance backbone*: The NSF backbone is migrating from a DS3 platform to a higher-performance network, based on ATM and SONET.

— *Expanding range of applications*: The internet has supported data networks, which serve the research and collaboration needs of researchers and educators employed by universities, corporations, and government agencies.

— *Affordability*: The internet remains one of the least costly approaches to provide interconnection, delivering on the NII promise of an affordable networking solution.

— *Extensive information resources*: This represents a source of strength of the internet as an application solution to distance learners.

— *Ease of use*: New services, such as WWW, make the internet easy to access and to use.

All these factors make the internet an important component of the NII, but it cannot be considered a complete substitute for the NII for the following reasons:

— *Lack of support for rural communities*: While it is widely available, the internet has not yet reached 'rural communities' with local access nodes.

— *Lack of information filters*: A range of information resources on the internet are not of the highest educational, social, or moral value.

— *The internet as a public forum*: Like talk radio, the internet has become a public forum, where ideas are generated, discussed, and debated.

— *No guaranteed performance*: The distance learning community needs to consider that it neither be guaranteed a certain throughput across the internet nor a consistent reliability level.

- *Lack of antiviral software*: Internet e-mail or downloaded files have been known to contain viruses, which cannot be eliminated without antiviral software on every machine in the network.
- *Junk e-mail*: Institutions connected to the internet can be flooded with useless and unwanted e-mail.
- *Security issues*: The security weaknesses of the internet limit its usefulness to interorganisational communications, including those associated with distance learning solutions.

Several solutions are becoming available to corporations that want to improve the security of internet access:

- *Screening router firewall*: This solution involves using routers configured using native access rules to filter packets at the IP port level. The benefit of this solution is that it may not require additional investment on the part of the corporation since the router may be a part of the installed base.
- *Application-level firewalls*: This solution provides a higher degree of security than a router firewall. The implementation of this method is accomplished by forcing users to access the system only via application-level prompts.

7

Distance Learning Principles

The traditional model of learning is based on principles of an instructor-directed environment. Learners have been required to do what the instructor tells them to do. This model is experiencing a shift to a learner-directed environment as learner requirements within the workforce increase due to a variety of factors, including constant technological change.

The key element necessary for any learning to take place is communication. In order for concepts, procedures, principles, etc., to be fully understood, the learner must communicate them to others. In addition, the learner must be able to demonstrate his or her ability to complete the learned task. Today we still send staff to a training facility, away from their physical workspace. This follows the traditional model of instructor-directed learning.

However, from this scenario learners only retain approximately 20 per cent of what they were taught. The other 80 per cent of what they were taught may be necessary to their job function, but not necessarily applicable on day one of their return to the workplace. The slack is picked up by calls to the help desk or "over the cube" training, where employees collaborate on an as-needed basis.

SELF-PACED LEARNING

Self-paced learning tools, in the form of CBT and EPSS, have been implemented at many companies to replace rather than augment instructor-led learning. Given the growing mass of products to choose from in this genre, learners can select the product that best fits their learning style. In this case, learning new skills or reviewing previously learned skills is directed by the learner with respect to learning style, learning capability, and learning time. Skills learned in this manner are applied immediately. Even more effective, learning occurs when the learner shares this information with others.

ONLINE LEARNING

A mushrooming variety of courseware is now available over internal networks, wide area networks, and the internet/ intranet. The advantages of round-the-clock access to learning at any location are apparent. In many cases, however, students are expected to work on their own, often with no guidance from an instructor. A great deal of discussion is taking place among educators concerning the effectiveness of this shift to asynchronous or on-demand learning. Every online learning educator is challenged to find the proper mix of asynchronous (self-paced) and synchronous learning to maximise their instruction.

FACILITATED LEARNING GETS RESULTS

The challenge for traditional teachers has always been to engage the students through interaction with them and the rest of the class. A live instructor, interacting with students, is an essential part of the successful traditional classroom. Over the last decade, multimedia learning has become a vital part of many learning systems, on CD-ROM, CBT, and now online.

The lessons of CD-ROM have been clear concerning asynchronous learning. In those cases where the CDs were delivered to the student without any intervention on the part of an instructor, the percentage of students completing such courses was lower than expected. When a live instructor was made available via phone, video, or in person, the completion rates increased. Facilitated learning motivates more students to achieve the desired results. There have always been cases of mission critical learning, where the knowledge transfer must be verified by definable results.

Facilitated learning has been the most effective method for training in industrial methods, technical fields, software skills, aviation, and many other areas requiring a high level of retention by students. Even such mundane tasks as computerised order entry can be a mission critical skill if it is vital to the success of a business. Facilitated learning maximises the impact of mission critical training.

ROLE OF THE INSTRUCTOR AS FACILITATOR

The role of the instructor in online learning depends on the type of training, technology employed, and as noted above, the expected results. The combination of facilitated and on-demand learning can take many forms:

Help desk model

In the help desk model of learning, the instructor is an on-call resource, available to answer questions and provide training over the phone to facilitate learning which is predominantly self-paced.

The 80-20 rule

In the learner-directed model, 80 per cent of learning takes place asynchronously and 20 per cent takes place through facilitated communication. This new 80-20 model takes place over a different length of time and with a larger "toolbox" than the traditional model. As we add more asynchronous learning tools to the learner's desktop or workspace, we still need to ensure that effective learning is taking place. This amplifies the critical role of an instructor or facilitator. For many types of training, the 20 per cent of online learning facilitated by an instructor is essential to make the 80 per cent self-paced learning successful.

Assigned homework model

In this model, learning is primarily instructor-directed with a portion of work done asynchronously. "Homework" is a specific task assigned to the learners by the instructor. The homework must be completed by a specific date. In a following class, homework is shared and discussed among the students. In this sharing of information, learning is reinforced.

Instructor Dependent Model

In this case, the instructor directs all of the formal learning. No formal asynchronous study is assigned. The learners work on their own only as needed.

The key to the success of each model is the individual instructor's ability to engage the learners in interactive exercises and meaningful discussions that enhance overall learning. As we will examine, online learning recognises the instructor as the critical element to successful learning.

TECHNOLOGY FOR FACILITATED ONLINE LEARNING

The instructor takes on the role of a mentor in the studio classroom, supporting the students as they learn interactively using multimedia modules on PCs. Dr. Wilson's experience suggested that an interactive online learning environment should have the following characteristics:

— Floor control to allow classroom coordination and content synchronisation for both instructor-led and student- centred learning.

— Compatibility with industry standard authoring tools for multimedia courseware including audio and video clips, animation, and simulation exercises.

— Question and answer tools to verify content retention.

— Shared whiteboard to add spontaneous material to courseware.

— Collaborative software for application sharing over the network.

— Text chat for group communication.

— Course administration tools for scheduling, registration, and resource management.

— Delivery on standards-based multimedia PCs.

— Flexible delivery modes to accommodate a variety of infrastructures, such as local and wide area networks, ISDN, and internet/intranet.

Instructor/student communications may be integrated with online learning using currently available technology.

Audio Conferencing: Telephone conferences connecting participants around the world are routinely used for business meetings. The same technology can be used in parallel with online data sharing to complete the facilitated learning paradigm.

Internet audio: Recent advances in compress techniques have made Internet/intranet audio practical to integrate with online learning systems.

Video-conferencing: Desktop Video-conferencing is increasingly available as the technology of choice for facilitated online learning, especially in mission critical training situations.

Building on customers, experience with their facilitated online learning software, ILINC has expanded the original vision of research to offer reliable, scalable, and flexible systems which leverage existing customer investments, while at the same time remaining true to the educational objectives of sound learning research. An expanding list of LearnLinc customers have recognised the importance of facilitated online learning for their training needs:

- At ProSoft, master trainers train 50 instructors around the country on the newest internet software—in just one day, with no travel.
- Rensselaer Polytechnic Institute connects graduate students in Troy, NY and Hong Kong across 12 time zones.
- Educational Institute delivers hotel management training online, using their best instructors, saving travel and lost productivity costs.
- As the most experienced company in the facilitated online learning field, ILINC is uniquely positioned to amplify the virtual classroom experience for thousands of training applications well into the next century.

FACILITATED FUTURE

When we understand the impact of the global economy, delivery methods for learning become critical. As trainers, we must address three key issues: reach, distribution, and leverage. We must be able to reach a wide audience with efficient distribution mechanisms while leveraging critical resources.

Technology has been able to help today's training industry produce faster and more portable ways to deliver learning. In fact it has created the on line learning industry. The internet and the corporate intranet are the new media for training delivery. Of all the online learning technologies currently available, few offer the capability to provide instructor-directed learning. Facilitated online learning allows for maximum reach to remote learners. It is an efficient media for distributing information quickly. It has the capability to leverage technology and subject matter expert resources. Whatever paradigm shattering technologies await us in the future, the role of the instructor is sure to be recognised as vital to ensure results-oriented online learning.

8

Open Learning: Medium of Education for All

Open education or open learning is an evolutionary modification of the educational approach to the teaching-learning system. While the two are not synonymous, a learner, at a distance, often finds the features and strategies inherent in the open learning system more suitable, and so chooses distance education, rather than face-to-face education, where distance education has incorporated the features of open learning.

The major features of open learning and distance education are given below:

i) It offers open or flexible entry conditions.

ii) It provides for accumulation of credits in subjects and thus qualify for certification, or diploma, at one's own pace.

iii) It offers a great variety of subjects and choice of subjects is left to the students, to suit one's personal needs and requirements.

iv) It provides bridge courses to assist in learning readiness so as to be able to move to a higher level.

v) The multimedia and integrated learning packages make learning easier.

vi) The specially prepared distance education text promotes self-learning, to a great extent, and the rest to be made up through personal contact classes and non-print media support.

vii) The provision of modules in a subject package and semesterisation add to the degree of flexibility that a student can avail himself of.

viii) The continuing internal assessment along with external evaluation in preference to only external assessment, is also a standard provision in distance learning system.

Open education is particularly characterised by the removal of restrictions, exclusions and privileges; by the accreditation of students' previous experiences; by the flexibility of the management of the time variable; and by substantial changes in the traditional relationship between the professors and students.

On the other hand, distance education is a modality which permits the delivery of a group of didactic media without the necessary regular class participation, where the individual is responsible for his own learning. The last decade has seen a phenomenal growth in distance education and the integration of this method of education into the standard educational provision, in a large number of countries, to such an extent that it is now no longer possible to think solely in the traditional sense of face-to-face contact.

The features and provisions of the open learning system, referred to above, would suit the needs and conditions of a broad spectrum of students, and hence can serve its client groups much more effectively. There exists a very sizable population, particularly those in the rural sector, women, deprived sections of society, such as scheduled castes and tribes, the urban poor, the unemployed or underemployed and the dropouts etc., for whom initial education has done very little. That is why, a more open and flexible approach, that takes into account, the needs and constraints of these, would indeed be, a welcome initiative.

To be effective, therefore, it is imperative that the open system is not a repeat of the formal system, in the matter of course design, teaching-learning methodologies and testing. The open channel has to preserve its area of freedom, for the sake of the client groups it wants to serve. However, it is a cardinal principle of the open systems to maintain equivalent educational and learning standards, without seeking point-to-point equivalence in topics, and much less in rules governing admission, certification etc., with the formal.

OPERATIONAL STRATEGIES

How does distance education function on the ground? How bridge the large geographical distances? How provide adequate support to the student, in far away places, to learn? And, above all, how to provide for such large numbers? With the kind of facility for access and choices, the number of those who wish to avail themselves of continuing education, are around to swell. While a college or school will have an annual fresh intake of a few hundreds or a thousand or so, well established open learning systems have numbers running to 50,000, 75,000, or 1,00,000 a year.

Distance education makes use of many strategies to reduce the gap and to find ways of effectively servicing the students. In this context, what O. Peters said, in 1973, is even more true today:

> "Anyone professionally involved in education is obliged to presume the existence of two forms of instruction which are strictly separable: traditional face-to-face teaching, based on interpersonal communication and industrialised teaching, which is based on an objectivised, rationalised, technologically produced interaction".

Distance education adopts many support strategies and uses many support institutions and their infrastructural facilities to maintain a high degree of efficiency and still remain effective.

Distance education text

Distance education text, is written specially for the distant learner, sometimes referred to as a teacher in print. It is written with the specific aim of enabling the learner to master a good percentage of the matter, on one's own, and having to rely on the teacher or non-print media, for the rest. It has, therefore, to proceed in large measure as a good teacher would proceed in a normal class, setting learning outcomes for a limited topic of study, asking (intext) questions, summarising, highlighting major or structural concepts, and reviewing the lesson, through a set of questions. Special end-of-despatch questions are also put, and feedback provision made, by giving, the answers on a separate page.

A well-prepared print medium accounts for 80-90 per cent or more of the actual learning. However, use of visual m media would have a critical or significant contribution to enhance the quality of learning. For example, in subjects like history, to show a rare document or a monument etc.; in geography and the physical and biological sciences, to show special processes and phenomena, rare species, living or extinct, but of replicas kept in museums or to show a dynamic process or movement etc., or in engineering or for acquisition of practical skills etc. Where the medium also carries a message, awareness cation can be greatly enhanced through the visual medium.

Student support service centres

The supportive institutions linking the students with the open school. There may be, in a large system, a number of supportive institutions, set up by the national institution, which in turn, link and are in contact with the study centres. The regional offices would then provide several student services, either directly or through established study centres of the region.

Depending on the organisational decisions taken by the national institution, admissions, despatch of study materials etc., and correspondence with individual students may be directly done by the national, office, while the regional office is made responsible for the orientation of teachers/tutors at the study centres and for supervision of conduct of personal contact classes.

Another alternative is to decentralise straight from the national institution to the accredited study centres, without having to go through the intermediary of the regional office.

Services that the study centres are expected to render would include:

i) Students admission, for, and on behalf of the national office, after students properly fill up the forms, submit the required documents and pay the fees.

ii) Soon after they are admitted to the courses, the services making available to the students, the materials in good time. Too much delay would result in loss of motivation and would also lead to dropouts.

iii) Distance text is so well written that the student of average ability is able to go through the learning material and master it with only limited additional support. It will mean providing sufficient feedback to the student as he progresses from lesson to lesson or topic to topic, by a variety of techniques, similar to the ones that a good teacher uses in a face to face situation. Thus the distance text is a distant teacher in print. Studies have shown, even where large-scale use of TV and radio support is provided, that the printed distance education text is still the major instrument of learning, accounting for most of it, up to 80 to 90 percent of it.

iv) The organised provision of personal contact classes, not many in number, but adequate to serve the needs of the students. These contact sessions, to be effective, must be dealt with differently from the way the teacher deals with formal students. Because of the limited number of contact sessions, the methodology will be to enable the student to become a self-learner, to the extent possible. Hence, a survey of the whole course and how the parts hang together is what a good tutor of distance education would begin with. Concept-mapping or mind-mapping is a way of getting the student to get to see and understand the basic structural concepts.

v) Additional support through non-print media. Large-scale use of educational TV is still only a plan and a hope, so is radio, although there are growing provisions being made, especially with the introduction of satellite communication.

vi) Providing institutional facilities for the periodic evaluation of educational attainments. These are of two kinds: one evaluating in the printed study materials, by way of review and to ensure understanding and the other, a more formal internal assessment, marked centrally by the computer, in the national or regional office. The availability of Optical Mark Reader (OMR) would make it possible to have very large number of scripts evaluated by the computer, and reports made and printed and given back to the students in a short time.

Computerisation

Hence distance education has to make use of the available computer services, for all major aspects: registration and admission of students and creating a student data base; registration of students for internal and external-examinations; computer-marking of some internal assessment tests, correspondence with students, using mailmerge facilities of the computer for personalising correspondence with individual students; print out of mark sheets, certificates and identity cards.

Apart from this, the large volume of data on examiners, moderation of examination results, for purposes of scaling and grading, can also optimally use the computer programmes. Personnel records, financial supervision etc., of the central office can also be assisted by computer programme support, which would then keep and easily retrieve specific data for different categories of users.

In fact, once a networked computer system is set up, authorised persons will be able to have access to various kinds of data, in the central computer unit, from a terminal, in their own rooms. Such use can be for decision making or for services to the students, who come asking for information, to obtain the results of an examination or for similar uses. The reception counter will then have to have a computer terminal, to retrieve specific categories of data and make these available to visitors.

Rules and regulations

A careful and discerning simplification has to be made, so that mindless rules, complicated procedures, while retaining proper accountability, do away with cumbersome formalities and filling up of too many unnecessary forms. By evolving permanent dates and calendars, for standard activities, like registration, internal and external examination dates, information and communication become easy and save a great deal of time and cost in terms of postage and telephones. Decentralisation is not a panacea for dealing with large-size problems and situations, but it offers a necessary strategy.

However for its effective use, precautions and fulfilment of certain conditions are equally necessary. It is necessary that the concerned persons, both staff in national and regional offices as well as partners in the study centres or accredited institutions understand and accept the philosophy and know the procedures. Hence, apart from being efficient and effective, the institution has to become and remain humane and responsive.

The demands are so big and challenging, that it is not possible to provide efficiency and effectiveness through the traditional bureaucratic channels of administration. There has to be, on the ground, real functional autonomy, for purposes of planning, decision-making and implementation. The fact that the finance, whole or part, is coming from the public funds, should not be used as a reason for interfering with the normal functioning of the institution.

Teachers orientation at the study centres is essential. In a large system, training and orientation can be entirely through face-to-face, or through a combination of distance education methods along with some face-to-face or contact classes.

Another essential factor is the supervision. But the approach to supervision can also be decentralised and democratised. One key to the success and effectiveness of such decentralised operation is the kind of friendly and on-going academic and administrative supervision that is exercised. Such supervision need not be thought of in the classical, highly stereotyped and bureaucratised fashion. More democratic forms can be evolved. If a cluster of study centres is given the responsibility to supervise themselves and to ensure that all the units of the cluster function well, and asked to organise mutually arranged visits and consultations to meet conditions and norms set by the central institution, that would retain accountability to themselves, to the students and to the central institution, but would also be more human.

Obviously, the central institution would also intervene, for orientations and also for visits, but the basic and first responsibility would shift to the members of the cluster. Another key to success is the actual transfer of necessary authority for decision-making from the central office and a few officers at the top, to the regional office, and to the coordinators at the study centres.

The operational strategies of the distance education and the open learning system thus offer an excellent alternative for us to move towards the goal of universalisation of basic education, which is also an essential instrument for human development.

There is a close collaboration between the institutions, providing infrastructural and training facilities and the open school, in all aspects, and stages, namely, curriculum development, and the proportionate weightage for the theory practice mix, evaluation and certification. The system of accrediting a course by the open school would enable it to certify the students who pass from a collaborating institution. The process of accreditation has to be by technical team. Here again, the team must have the basic suppleness to insist on required standards of theory and skill acquisition to meet the demands of the job, without succumbing to the pressures of conforming to an existing formal curriculum.

Technologies are developing fast, and unless training keeps these in sight, trained persons will be unfit to meet the demands in the market place. Hence, updating eduction and training gain importance. The emerging scenario, in a technology-intensive society, will be for more and more trained and skilled manpower. Access to the formal route is difficult, and unnecessarily long, in many cases, apart from having little organised provision for updating or continuing education and training. That is why, the open system must support and complement the formal, by providing both first-time short and longer courses in vocational education, as well as updating and continuing education and training.

Continuing education, not necessarily for a certificate, but for life-enrichment, for job satisfaction, or for a variety of life needs, or to pursue an interest or hobby and to acquire various kinds knowledge and skills, whether in citizenship education, legal literacy, health family education, or for personal development and recreation, all offer scope for provision through distance education.

Jerome Bruner once said that it is possible to teach, in an intellectually honest manner, any topic, to a person of any age. Something similar could be said of distance education, as a medium for providing adequately education in a wide variety of academic and technical skills, if proper links and strategies are ensured. In-service education of teachers, of key persons who work in adult education centres, or health workers and a variety of others, in different development sectors, who need new or continuing education, are some of the other possibilities.

The experience of those involved in distance education is that the relative costs are less, and often much less, whether for school level certificate education, or for a course leading to a university degree. This is so, even when large-scale use is made of the electronic media to support print and contact classes. The main reason is the fact that the numbers involved are large, and hence the cost is reduced. Situations and conditions that appeared as great barriers and obstacles can be face and overcome, with patient and preserving use of open learning and distance education, supplementing and complementing the formal, by providing an important educational alternative.

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Specification of On-line Lectures

Producing courseware with some of today's authoring systems requires knowledge and even programming skills. For example, courseware often places an overreliance on hierarchically arranged structures that effectively hide information and allow the act of exploration to become an educationally purposeless activity. Information is often updated in a computer-efficient manner, the resultant movement leaving students cued to the wrong place on the screen. Having to think about relocating their focus of attention interferes with what they are learning. There is a temptation for the lecturer-developer to include multiple paths along which students can travel by pointing-and-clicking, leaving the students in danger of losing the focus of their learning objective.

Indeed what is actually required is support for a personal discovery of insight, not the chance discovery of already publicly known facts. Widely available development environments actually leave authors open to more bewildering design considerations than did previous generations of authoring systems. So one approach is to form teams consisting of the lecturer, an educationalist, a programmer, and a user-interface designer, an expensive approach that has been found to be unattractive to educational institutions.

Metaphorical-based Learning

Students should not be regarded as pots into which facts and concepts are poured without it being necessary for them to embark on any cognitive reorganisation and conflict satisfaction. Students have achieved successful learning outcomes by attending lectures, reading textbooks, and then personally consolidating the material. If information technology is to be exploited then one of its main contributions should be to speed up the learning process. This can be simply achieved by removing the tedious impediments to learning such as note-taking errors and repetitious clerical activity, and ensuring that concepts are explicitly described and illustrated. If lecturers are to be encouraged to exploit information technology then preparation time ought to be of the same order as for 'talk and chalk' lectures and problem classes and achieve the same level of quality as they do without IT. But exploiting the computer should provide an upgrade path to higher quality in the learning experience.

The authorware must allow lecturers to concentrate on their specialities and not on the design of the navigational interface. They must see that they can withdraw from the process without loss of time. So an alternative proposal is to base courseware development on familiar metaphorical paradigms.

LECTURE-BASED LEARNING

The material conveyed in a lecture is more thoroughly covered in textbooks, but the lecture conveys the material in a more easily digestible form, preparing the mind for the more complete coverage in the book. While the lecture theatre is not the place where most of the learning takes place, its prominence in the learning process has stood the test of time. Students overwhelmingly demand the retention of live lectures. Lectures offer a framework that identifies the scope of the material. They lubricate the learning process that takes place later during private study when the material is consolidated. Lectures structure the working day, provide social contact and interaction, and an opportunity for students to interrogate a human expert.

METAPHORICAL BASIS FOR THE USER-INFERENCE

The metaphor on which the system described in this paper is based, is that of the conventional lecture presentation, a situation familiar to university lecturers. It provides in one place on the screen the integration of text, diagrams, animation, illustrative pictures and video material, all sequenced and synchronised with a spoken narrative into a linear presentation. This compares favourably with the live-lecture situation in which projector foils, 35mm slides, video and audio are all controlled by different pieces of equipment and displayed possibly in different parts of the lecture theatre.

The metaphor used for both the creation and presentation of each lecture is that of an electronic book whose content can be roamed in much the same way as with a real book even down to experiencing the same page turning cues that are inherent in real books. Students may have the whole lecture played in sequence (stopping where necessary); they may truly browse to any slide and have it 'played' through, or see/hear a fragment of the sequence. Thus students can passively experience the lecture, or navigate non-linearly around it. Links to external material such as supportive technical papers held locally or on the World Wide Web can be incorporated together with additional notes below the slides.

The picture of the aeroplane is in colour (and may be found at web reference: http://www.british-airways.com/bans/mworld/planes/7474.htm). Two of the fragment access buttons have been greyed, indicating that the music is playing and that one picture has already been displayed. A visual programming method is used throughout to specify both the content of the slides and the dynamics of the presentation. This method is based upon a schematic drawing paradigm. It might be useful to regard this as a fifth authoring paradigm alongside those of structure, time-line, flowchart and script as identified by Hardman and Bulterman. While there is some resemblance to the flowcharts approach, the flow lines are absent, the sequence is determined instead by the relative position of symbols, and the flowchart is placed on the slide rather than have the slide content accessible through the flowcharts. In some ways the emphasis is on fitting the dialogue to the picture rather than fitting a picture to the dialogue; though of course a presentation should be prepared using an iterative process and the system allows for this.

SYSTEM DESCRIPTION

The central software (called OHP) uses the Book Emulator as its user-interface mechanism and they are connected together through two-way UNIX pipes. The whole system runs on a Silicon Graphics Indy. The Drawing Board requires porting from Sun Microsystems hardware.

The Book Emulator

The Book Emulator presents a book-like user interface to information enabling that information to be truly browsed by flicking through the pages of an electronic book. The page turn is animated, indicating directional travel, and the splayed page images down the sides of the book change size according to the user's position within the information space. Two mouse buttons provide for forward and backward travel, while the third button enables selection.

A number of central services are provided through the utensils located above the book including word and symbol searching, proper bookmarks, inter-book hyperlinking, and an import gateway for external links to arbitrary fragments of information. The Book Emulator has a schematic drawing capability based upon symbols that are interconnected by lines and annotated with text. When a symbol is selected it is attached to the mouse cursor and can be relocated on that page, moved to any other page within the book, or moved to any other book that is also open on the screen.

A grouping facility automatically groups lines, text and other symbols that are contained within a symbol. The last item or group selected is remembered through the 'glue-pot' and its content is available in any other book on the screen that has a glue-pot. The utensils located above the book provide for the moving and copying of complete diagrams and, of course, when attached to the mouse cursor these may be dragged to any other page within the book or to any other book. Symbols, text, lines, groups, whole drawings may be deleted by selecting and tacking outside the confines of the book. Symbols and fonts are usually selected from library books containing such collections. Two function keys are provided to speed up drawing. If either is pressed when nothing is attached to the cursor, then what is in the glue-pot is attached to the cursor. This enables the fast repetition of a symbol in a drawing without the need for a large movement of the mouse cursor up to the glue-pot. If a symbol is attached to the cursor then pressing the function key causes it to be changed to a related symbol if one exists. In this way, for example, having selected a transistor symbol, the different orientations of the transistor are quickly available to the user.

The two function keys cause the changes to go opposite ways around the 'ring' of related symbols. If a string of text is selected, then the appearance of the string is changed when the function keys are pressed. For example, the text might be made bold, italic, underlined, squeezed, outlined and so on. If a line is attached to the cursor when the function keys are pressed, the line appearance changes to dotted, dashed, and so on. User-authored links to external fragments such as audio, pictures, movies and other books are available through special symbols which act as anchors. Their manipulation is identical to any other symbol, so may be moved within and between books, be grouped, and be changed with the two function keys. However, when they are 'long selected' their content is displayed or heard.

The central system

The central system is fronted by a book that provides for up to two library books to be open at any one time including a library book maintained by the user for collecting often used symbols, text strings, or privately created symbols (pictures). Up to twenty slides per book can be created. Through this interface the lecturer can create paper-based booklets of slides for students (one slide per page with room for personal notes, or two slides per page). In addition another booklet can be created, this time with the slide followed by a blank story-board table all on the same page.

The lecturer can also create a set of slides, one per page, for transfer on to view-foils or 35mm slides. Two electronic hardcopies are available. One creates a HTML file suitable for a Netscape type viewer, while the other creates a HTML-compatible file that has additional tokens. This enhanced HTML file is automatically passed through a separate converter that creates a book version of the electronic slides. One of these additional tokens forces information to begin on a new page and another enables dynamic instructions to be passed through. These dynamic instructions are required for animation and the sequential spoken narrative, facilities that are not available through viewers such as Netscape. Creating this added complexity means that online lectures displayed through the Book Emulator could be transmitted over the World Wide Web for final viewing through the Book Emulator.

VISUAL PROGRAMMING OF LECTURE SPECIFICATION

Creating on-line slides

The creation of online slides exploits the schematic paste-up facilities of the Book Emulator. It is arguably no slower than any other method of slide creation including those written by hand. Lecturers need go no further than this to have benefited from using the system and, like other systems, slides can be edited.

Creating online lectures

The minimum requirement for changing online slides into online lectures is to provide a spoken narrative and the sequencing of that narrative is visually programmed with the same schematic paste-up facilities as are used to create the slide content. The audio fragments are usually of thirty to sixty seconds duration (one to four sentences) and are captured on to the local fileserver using a separate audio capture tool. With a single command, the speech fragments are imported into the Book Emulator's in-tray, that is located above the book. From there, their link symbols are extracted and placed in position on the slide.

They are sequenced according to a left-to-right, top-to-bottom rule that has a degree of tolerance which enables the correct sequence to be interpreted without the need for exact alignment. By default the command that sends the anchor to the in-tray assumes that an audio file contains speech and chooses one of the speech symbols (the speech bubble). Using the function keys this symbol can be changed by the user to identify it as music.

As well as showing the whole slide all the time, some lecturers like to reveal material gradually as they progress through the slide. Others prefer to point to the bullet point currently being discussed. To specify what has to be revealed or indicated at any point in the sequence, the slide must be partitioned with 'rule-off symbols. Then any speech fragment between rule-offs is sequenced after the revelation or identification has taken place. In this way the lecturer can specify what is to be revealed and what has to be said after that revelation. In the top part, there are two speech fragments and there is one speech fragment in the lower part.

A link to an external document is specified below the last speech bubble. The Notes-Jot anchor leads to the 'additional notes' that are placed below the fragment access buttons. Behind the specification book is the library book that contains the special symbols needed in the specification. This book also contains, on other pages, some fonts suitable for OHP production and general block diagram symbols. It is important to 'top and tail' a lecture; that is, to begin by defining the scope of the lecture, describing the benefits that will accrue from understanding the information, and reminding the students what they should know as preparation for what is to come. At the end they need to repeat that information, emphasising how the new knowledge can be used.

In consequence, it may be useful for the lecturer to show briefly some of the key slides and this can be incorporated in the sequence with the 'show slide' specification symbol. Colour pictures and movies can be incorporated in a slide by placing them appropriately in the sequence of specification hyperlinks. These links are imported into the Book Emulator through the in-tray using the same command as for the speech fragments. Colour pictures and movies can be used to illustrate aspects of a lecture (examples of jet aircraft) as well as be central to a lecture (for example, the discussion of a famous painting). In the latter case and in situations where a set of pictures with accompanying music is needed, it is necessary to specify 'parallel audio' which causes the audio to be played as the pictures are being displayed. While the revelation/indication mechanism works particularly well for slides containing textual bullet points, it is not satisfactory if a diagram is to be described in which, for example, flow of data needs to be animated or the diagram needs to be built up as the narration progresses.

In these circumstances it is necessary for an animation book to be included in which the individual frames of the animation can be specified. This book is the same as that fronting the OHP programme. The content of each animation frame is pasted up in the same way as all the other slides and the same specification facilities are also available; but in going from one frame to the next, there is only a short delay imposed, thus enabling animation to be shown in steps (rather than continuous). Only twenty frames are available in the animation book, but animation books can be nested.

AUTOMATED CREATION OF ONLINE LECTURES

The central software (OHP) generates different HTML files for the World Wide Web browser and the Book Emulator versions of the online lectures. For the Book Emulator some additional tokens have been defined to accommodate the notion of pages, enabling each slide to start on a new page. In addition the necessary animation instructions are also passed through so that a lecture can be played. For the World Wide Web version no such dynamics are possible but each fragment of the sequence is made available through a point-and-click button interface as they are in the Book Emulator. It is not really correct to call the World Wide Web version 'online lectures' since no lecturing is actually supported.

Overall presentation

The online lecture generator goes through each slide visually removing the lecture specification material, leaving only the slide content. The cleaned-up slides are then bitmap dumped, resized appropriately without loss of detail, and if being prepared for the World Wide Web are coloured according to the 'colourway' specification. Such colouring ensures that the slide, background, and button highlights are all colour coordinated.

Below each slide the fragments of the lecture sequence are accessible through buttons (also colour coordinated). These buttons are titled: narrative (for speech), picture, movie, document, www link, music, or textbook. Below the fragment access buttons, additional notes may be included. These notes are created with an editor (changed using the function keys) and are converted into HTML. HTML tokens may also be used provided they are recognised by the HTML-to-Book Emulator converter.

Among other facilities, words or phrases can be made bold, inline images may be incorporated, and further hot references may be included. In the Book Emulator version where the lectures are dynamic, the student can go to the front of the book and select the button that causes the whole lecture to be played through with all the covering-up, revealing, animation, overlaid pictures/movies correctly sequenced with the spoken narrative.

The speech can be paused and resumed by pressing the spacebar and when resumed it plays the last few seconds again before carrying on. This enables users to orientate themselves before the next part of the information is conveyed. Pressing the backspace key causes a bigger jump backwards in the speech. The complete lecture can be stopped, and then can be resumed by selecting the button at the front of the book; it continues from the start of the slide at which it was stopped. Alternatively the student can browse (by flicking through the pages) to a particular slide and select it and see it dynamically presented.

In either the complete lecture case or the single slide case, the last fragment heard or seen is indicated by greying the appropriate access button below the slide. By the end of the slide, all the access buttons have been greyed and are then restored when the sequence ends. This process indicates which of the access buttons will return the user directly to a specific fragment. Notice that the access button is not greyed while the fragment is heard or seen and then restored when it has finished, because this would attract eye movement away from the slide and its animation. The Book Emulator allows the student to make personal annotations either directly on to a book or through electronic Post-Its like that used to specify the 'additional notes'. Furthermore, links between individual slides both in and between books can be installed by creating a link to the current slide on display using one of the utensils.

The resulting anchor is then selected from the in-tray and taken to the slide where the link is to be made, placing it where it is most appropriate. For an explicit two-way link, the process is repeated the other way round.

GENERAL DISCUSSION

Writing online lectures is similar to that of writing a book in that they are both published, albeit in different forms. They are therefore available for scrutiny by peers. Thus more care is taken in preparing the material, and this must lead to higher quality. Koumi offers some useful guidance for creating educational videos that are attractive to the target audience and this has been interpreted elsewhere specifically for online lectures. The lecturer is advised to script the narrative, breaking it down into speech bites of perhaps one to four sentences such that it contains an atomic piece of information with perhaps some qualification.

The lecturer is then advised to record the speech bites away from any background noise such as the cooling fan of a desktop computer. In practice this means recording on audio tape at home. Prior to recording, the narrative needs rehearsal and must be spoken with at least the same flamboyance as that conveyed in a live lecture. Preferably they should be even more flamboyant to counteract the lack of any body language such as gesticulations that would naturally arise at a live presentation.

The whole process is clearly very time consuming and in the author's view is likely to discourage the take-up of on-line lectures. However, it does ensure that the slide can be talked through in an orderly way, that all that needs to be said is captured, and it does provide the cement that is necessary to make the slides properly understood. In this way the additional spoken narrative improves the quality of the 'electronic slides'. While a similar tedious process may be experienced when incorporating movie clips, the majority of lectures require no such sophistication.

However when required to illustrate sequential and temporal activity in a real-world situation (e.g., user-interface design, personnel management, chemical experiment), then its inclusion adds to the quality of the lecture. Movie clips are captured with tools that are external to the system described in this chapter. The view-foil versions of electronic slides are almost guaranteed to be readable from anywhere in the lecture theatre. Their editing is straightforward and thus a course can be easily kept uptodate. Furthermore, in principle, fragments of material can be shared with other members of staff and tailored by them for their specific student needs.

However, it should be noted that a change in voice, even the same lecturer's voice after several months, can be wrongly inferred as a change in topic, or that it is a conflicting view compared with the previous statement. So editing the spoken narrative requires some care. Editing of course amounts to throwing away fragments and recording and inserting replacements. In practice, the author has adopted the inclusion of the scripted narrative as the 'additional notes' that appear in the online lecture below the fragment access buttons. This enables students to speed read and also to not have to listen to the author's voice. But there is some evidence that students simply follow the script as the narrative is spoken and therefore are not focused on the animating slide. It may be that the author needs to change his policy on this matter.

TOWARDS THE VIRTUAL LECTURE THEATRE

When originally conceived the emphasis was to use information technology in the lecture theatre as well as having exactly the same material available online for private study. Students want live lectures. But unless the institution is prepared to equip lecture theatres with projectors with high resolution and high light output, the resultant presentation would need to be undertaken in a dimly lit lecture theatre with students straining to read the fuzzy lettering on the screen.

Using the conventional overhead projection view-foil overcomes these problems. And yet the integration of animation, pictures and movies is a strong motivator to provide the online lecture in a form that would enable it to be presented live by the lecturer while signalling step changes just as weather forecasters do on television. To this end, work is proceeding to provide a third version of the online lecture which will be created in the form of a HTML file with embedded Java tokens. This will enable the lecturer to single step forwards and backwards at both the fragment and slide levels without the spoken narrative, as well as be able to play the whole lecture through with the lecturer listening with the students.

While the lecture paradigm may be regarded as a straitjacket, it also offers a completely choreographed show with no new skills to learn except that required for a slide projector type control. Unfortunately it appears that the user-interface particularly with regard to timing, cannot be as well controlled as it can be within the Book Emulator and so association/dissociation may well be hindered in the continuous play version. This problem will be heightened when there are delays on the local area network and the speech (which can only be made to run sequentially with the revelation if appropriate delay estimates are inserted) is still playing when the next part is revealed. There is also a need to offer students support for fast nonlinear access to specific topics that might be 'buried' in a particular lecture.

If the concept of online lectures is vigorously supported within a department then each lecture course in each year would be available to students. It is envisaged that each course year would be accessed through a Role Controller displaying each course as a book on a bookshelf. Selecting one of these books would take the user to the index/search book for that course as described in the previous paragraph, and from there the student would access individual lectures within that course. At that stage the virtual lecture theatre will have been achieved and any lecture would be available 24 hours a day, repeatable as often as required.

RESOURCE REQUIREMENTS

The major additional time consumer (over and above that which would be spent on creating the lecture material) is the capturing of the spoken narrative. Given that this needs a rehearsal, recording on to audio tape, listening to it on audio tape, recording it on the file-store, listening to it from the file-store, the minimum additional time to provide the narrative is five times the run-time of the online lecture. In practice, it is more realistic to expect this ratio to be ten times the final run-time of the lecture and so it probably doubles the 'talk and chalk' preparation time.

10

Interactive Learning over the Internet

Global Information Systems Technology Inc. implemented a hybrid internet course for the Army. The INTech project provides technological solutions that satisfy military training needs. The domain for this project is the Military Decision Making Process (MDMP) for the Advanced Armor Officers Course at Fort Knox. The MDMP includes Mission Analysis; Course of Action (COA) development; drawing a COA Sketch; writing a COA Statement; and analysing COAs to select the best COA. The MDMP domain provides a significant courseware development requirement, having a high probability of affecting the methods of future courseware production for similar Army and Air Force domains.

The MDMP is currently instructed over a four-day period; contact time is 32 hours. The automated courseware covers the same materials and objectives.

FRONT-END ANALYSIS (FEA)

A front-end analysis was performed to ensure the course would meet training objectives that are validated against real job requirements. The approach was eclectic, based on the experiences of the team in doing FEA. Initial contacts with domain experts (DEs) was by phone. Course materials for MDMP training were gathered and evaluated. This evaluation guided the selection of instructional strategies, the media selection, and the advanced technology selection. The materials were considered uptodate and suitable to create the interactive courseware for this project. New measurable objectives were created for the course based on the materials and discussions with the DEs.

CLASS OBSERVATIONS

The team travelled to Fort Knox and observed an ongoing class. This allowed the team to:

- observe the communication between the seven functional positions that the small groups (SG) of students role play;
- broaden our understanding of the tasks of the seven positions;
- observe students creating overlays/MDMP products;
- observe how the small group instructor (SGI) prompted and advised students;
- observe the Commander's briefing;
- gain a further understanding of the Armor School's expectations for the courseware;
- observe the creation of maps;
- observe the SGI prompting and advising students;
- observe the commander's briefing/presentations of each position; and
- meet with domain experts (DEs).

PREREQUISITE REQUIREMENTS

The team met with a contractor building courseware that is a prerequisite to the MDMP course. The team:

- delineated responsibilities,
- reviewed flowchart;
- discussed standards and level of interactivity;
- viewed a demonstration of a small sample of the course; and
- discussed standards and level of interactivity and fidelity.

MEETING WITH DOMAIN EXPERTS

The team met with DEs to gather information. They:

- met with representatives of four of the seven positions the SG represents when doing the MDMP;

- discussed objectives previously defined with DEs and the government PM;
- built a list of information students must reference to support the learning tasks;
- delivered a form to assist DEs to collect data for the courseware: and
- completed the information collection forms.

The meetings with the Army POCs and DEs were essential to determine the courseware design and development. The information helped to:

- create a user environment that simulates the work experience, allowing users to interact to solve a problem;
- develop a graphical interface to allow students to create and edit overlays/MDMP products efficiently;
- develop hints and feedback, possibly some intelligence to emulate the instructor;
- provide a technique to allow the seven staff positions to "look up" information; and
- develop ideas for how to make creating maps more efficient.

DESCRIPTION OF DOMAIN

The MDMP planning exercise reinforces the doctrine, planning, and decision-making knowledge/skills. The JANUS simulator is run at the battalion level, with all students divided into command and support functions. The SIMNET simulator is run at the company level, with all students manning specific tank operation positions. These exercises are planned and executed against an OPFOR composed of the instructor group. Field exercises are restricted to terrain appreciation and leader's reconnaissance of the battlefield.

DESCRIPTION OF CURRENT COURSE

In the current training, the SGI presents the small group with a situation and commander's guidance. The small group is required to exercise the decision-making process and analysis tools detailed in the text, and produce intermediate "products" used as input to the next phase of the process. The final product is a recommended *Course Of Action* (COA) plan, which is briefed to the commander. The Army has traditionally viewed military decision making as both science and art. Many aspects of combat operations, such as movement rates, fuel consumption, and weapon effects are quantifiable. Therefore, the Army considers them to be part of the "science" of war. However, the Army cannot quantify other aspects—the impact of leadership, the complexity of modern operations, and uncertainty regarding enemy intentions/actions/reactions. The Military Decision Making Process (MDMP) is a systematic approach to decision making, which fosters effective analysis by enhancing application of professional knowledge, logic, and judgement, and consists of six steps:

- Recognise and define problems.
- Gather facts and make assumptions to determine the scope of and the solution to problems.
- Develop possible solutions.
- Analyse each solution.
- Compare the outcome of each solution.
- Select the best solution available.

The architecture for the application of technology to this training requirement will involve two major efforts:

- the implementation of computer-based training activities to provide mission guidance, provide detailed data for analysis, and to capture small group intermediate and final products; and
- the implementation of distance learning technology to link the SGIs with the small groups during and after the construction of the intermediate and final products.

DESCRIPTION OF HYBRID COURSE

The automated instruction functions provide situation details required for each phase of training action. The small group functions are still completed in small groups. The distance learning functions provide the organisation and communication methods for the small groups to get help during the small group actions and to receive feedback on the small group products. Gates are closed until the student products are reviewed by the SGI. The SGI grades the products and opens the gate before the group moves to the next MDMP phase.

The MDMP includes Mission analysis; Course of Action (COA) development; COA analysis and comparison, and decision and execution.

PERFORMANCE REQUIREMENTS

Successful completion of the final product for each phase are:

Primary operational environment

The Fort Knox Campus is the primary operational environment. The campus environment is the local area network, the available networked computer systems, and the client and server software.

Secondary operational environment

Distribution via the world wide web, WWW, is the secondary operational environment. This will be used to service Reserve and Active Duty forces for refresher and preparatory training.

The TOOLBOOK activity will provide a simulated environment for: the request for information by the small group; the feedback of the information; and the control of simulated time to accomplish the discovery of the information requested. A team of four AOAC students will use Microsoft Word to provide a written text and graphic to communicate the intermediate products in a format for the SGI to review. The Word documents will be filed to a server, organised by an e-mail notes file package.

The instructor will comment on the Word document using the Word annotating features, which allows comments to be made without including the comments into the main document. The instructor will annotate the drawings; these comments are included in the original drawing.

Mapping editor

The modified product, called MAPEDIT, consists of the original TIEPAINT and two added pop-up menus, labelled ViewLayers and EditLayers. The ViewLayer menu has eight items, numbered one through eight. A student can check any or all of these items, and the corresponding layer(s) will be displayed. The EditLayer menu item allows a student to select which layer he wants to currently edit. The editor is basically the standard TIEPAINT "vector" editor. Each vector object has an extra "tag" on it, which indicates which layer it belongs to. When items are displayed, only those items which are part of the active layer(s) are displayed. The scheme is simple, and works very nicely. MAPEDIT is a 32 bit Windows application developed using Microsoft Visual C/C++ version 4.0. The source code consists of various c, h, dlg, ico, .bmp, all of which comprise the actual "project" file. There is also a "help" file, which uses Microsoft WordView to display hypertext style help.

Data flow

Student and instructor workstations exchange data via a shared directory on a network server. We do not want to hard code the path to the shared directory. Instead, the directory path is stored in an INI file on each workstation: $WINDOWS\TDMP.INI. The section is "Server" and the entry is "Root." In keeping with Windows convention, the INI file is stored in the Windows directory of each computer. All programmes that reference this file should use the GetWindowsDirectory function to get the name of the Windows directory rather than hard coding the usual path. The group file 'serves as the main repository of information about the group's progress through the TDMP lesson. In a production version of the system, group information would be stored in a full-featured relational database with internet capability. However, the proof of concept version will use a simple Windows initialisation file ("INI" file).

Evaluation

Participants

The primary role of the instructor is to facilitate the tactical decision-making process as students try to formulate effective course of actions (COAs). During the decision-making process, students are assigned one or two functional roles in which to analyse the information. A total of seven roles are divided among the four students in each group. Students must submit two interim products and one final product. The instructors will review, score, and provide feedback to the group for each submitted product.

Independent measures

The independent variables to be manipulated include instruction and online help. The dependent variables that will be measured include: (a) achievement and efficiency as scored by instructor ratings of the three submitted COA products and the time it took to reach the COA products, (b) subjective workload, (c) the mental model developed during the tactical decision making process as measured by paired concepts, (d) the rate and quality of communications across teams and, (e) affective preferences. Covariates will include individual differences in subject matter knowledge as scored on a pretest and prior field experience.

Achievement and instructional efficiency

The instructors for the course will grade these products. Each instructor will be responsible for scoring half of the products produced by each treatment group. In addition, the products will be submitted to the instructors using codes so that they will be blind as to the source of the product. These methods will be used to prevent bias toward a particular treatment condition. The amount of time the students took to submit each COA will also be recorded automatically by the system. In the traditional classroom treatments, the instructors will log the time of each lesson taught. Any additional help by the instructor to various students outside the classroom will also be logged.

Collaborative learning

The issue of collaborative learning is relevant for this project as students in both learning environments will be working together in four-person teams. In addition to these four- team members collaborating together to meet a mission objective, these teams are encouraged to seek advice and information from the other teams formed within the class.

Interaction frequencies

Computer-mediated learning involves many, sometimes radical changes in communication patterns. Rather than numerous verbal and non-verbal cues available in face-to-face encounters, distance learning environments constrain contact to primarily text. Typically, user acceptance of distance technology requires changes in how one thinks, composes materials, and communicates. Researchers point out that often new learners appear to experience some form of "culture shock" which dissipates with additional practice and experience with the system. In an attempt to quantify these reactions to the medium of communication, learner discussions will be audiotaped and transcribed verbatim. From these transcripts, independent raters will classify each recorded learner interaction into one of four categories suggested by the measurement of computer-supported collaborative work: management, social, task, or content.

Teaching a Remote Distance Program via the Internet

The notion that the classroom is the basic environment for learning a discipline has been questioned in recent years. In fact, since the use of the satellite and more recently the use of video conferencing concepts like that of the virtual classroom, distributed multimedia environment and the like have been a favourite topic in seminars and conferences worldwide. In August of 1997, the department of computer science at James Madison University started a remote distance master programme with a concentration in information security.

The experiences of this programme have taught us that, although not suited for everyone, it is possible to develop a new and "almost lectureless" paradigm for adult education. Our collective experience has provided us with an optimistic view of the results and the fact that it is a feasible task. However, to provide the reader with a clear understanding of this new programme let's first address the key issues of the target audience, and the modality of the remote distance program.

AUDIENCE AND INITIAL REQUIREMENTS

The programme started during the third week of August, 1997 with a cohort of about 25 students. These students were all practitioners of the information security field with diverse backgrounds and experience in computer programming. All applicants worked full-time at private organisations or government agencies in the Northern Virginia area. It was clear that a programme of this nature was not suitable for everyone, in addition to the normal requirements of the graduate school like GRE.

A committee of three faculty members reviewed the credentials of the applicants and made recommendations for acceptance into the programme to the director of the computer science department. In those situations where there were doubts about a candidate, one or more members of the admission committee talked to the candidate to request further information. To provide an additional check, the director of the department reviewed independently the applicants recommended by the admission committee. In cases where there was disagreement between the recommendation of the committee and the evaluation of the department head, the committee was asked to further justify its recommendation. There were about 80 applicants for the initial cohort.

Since an undergraduate degree in computer science is not required to be admitted into the computer science master programme at JMU, students that are admitted into the programme but deemed deficient in computer skills are required to take three remedial courses. These three courses combined provided a good starting foundation in the areas of computer programming in C/C++, Computer Architecture, and Data Structures. All the students, including those who did not have to do it, took the remedial sequence.

MODALITY OF THE PROGRAMME

The remaining "sessions" of the programme are via internet with heavy emphasis on the use of electronic mail. Students are free to communicate with the instructor via telephone, fax, or by any other means. The students access all the information through a website which contains the course description and the activities that the student needs to perform such as readings, assignments, and some ancillary material that may have been prepared by the instructor. Students are encouraged to participate in "threaded discussion groups" with minimal participation of the instructor, although the instructor clarifies any point that has reached a plateau and cannot be resolved by the students. It is important to observe that no specific questions pertaining to exams are allowed for public discussion. Students are requested to submit a "screen" name to the instructor. This name is used to post grades and all students have access to the grade screen.

11

Tutoring Tools in a Computer-Integrated Learning

Traditional intelligent tutoring system (ITS) designers have attempted to provide tutoring facilities that try to satisfy all of the student, teacher, curriculum and institutional needs. However, this has proved to be an immense task. An increased understanding of this immensity has brought about increasing recognition of two concepts.

The first relates to the general acceptance that knowledge has a contextual component and that the context provides a principled way to cluster, partition and organise knowledge. The second relates to the acceptance of the role of a student's common sense and general problem-solving abilities in the learning process—some researchers arguing that human tutors virtually never provide the sort of explicit diagnosis of student misconceptions that is sought to be provided in a traditional ITS.

It is also important to examine the suitability of diverse technologies in an educational context. It would be useful to identify the differences between computers and other educational technologies. In a learning context, a video clip accompanied by audio on a multimedia computer is no different from seeing it on a video player, unless the computer offers some opportunity for interaction.

The value of such interaction, apart from the morale-boosting confirmation of a correct action, lies in the province of learning by mistakes. This demonstrates that the know-how type of knowledge is more suitable to computer-based learning. With the increasing demand for a broad based appreciation of multiple disciplines, there is an increasing pressure on academics to ensure the transfer of adequate skills to all students, some of whom may be less motivated than others. While staff resources for lecturing are relatively less affected by this increased demand, the tutorial aspect of teaching requires a growth that cannot be met due to insufficient funding. Increased reliance is placed on self-study, which poses no great problems for well-motivated students; however, it is the remaining students for whom an adequate level of knowledge transfer has to be ensured either directly through the teacher as an instructor or indirectly through the teacher as a facilitator for adequate knowledge construction.

The resource intensive tutorials generally deal with the operational (knowhow) aspect of knowledge and are suitable for software tutors as noted above. This opportunity of harnessing computers for education creates a need for interactive software tutors and provides the basis for the work reported below.

DEVELOPMENT OF PROTOTYPERS

The funding was obtained on the strengths of DOS-based prototype software to support the teaching and learning of marginal costing. The prototype was developed in order to demonstrate the utility of applied artificial intelligence to student learning in introductory numeric disciplines and to date has been used by more than 3,000 students.

Unlike traditional intelligent tutoring systems, the Byzantium project has a modest aim—that of producing intelligent tutoring tools (ITTs) that extend a lecturer's scope. This is achieved by horizontally partitioning some of the teaching activities, e.g., supervising the development of operational skills, and assigning them to a computer tutor. It should be recognised that computers, though quite powerful, are only one of the educational technologies that can be applied in a teaming environment. This recognition in itself causes a shift away from comprehensive ITSs to ITTs that can be mixed and matched with other educational technologies and human teachers in various configurations in order to create a computer integrated learning environment (CILE) to suit classroom-based, open and distance learning strategies.

MODEL OF COMPUTER INTEGRATED LEARNING

One approach to computer integration within a learning environment is reflected in the Byzantium model of CILE. The aims of the approach are:

— to use computers and humans for what they are (currently) good at;

— to employ useful software tools within the overall learning environment consisting of human teachers and educational technologies;

— to add a level of applied artificial intelligence to the software tools in order to provide a degree of support to students thereby enabling them to work by themselves;

— to let intelligent tutoring evolve in a bottom-up fashion rather than be designed top-down;

— to understand the economics of the learning environments and be concerned with assessment and course management as they consume substantial human resource—the system should provide economies of staff time in all areas of the teaching cycle, e.g., exposition, example setting and grading work.

— to appreciate the economics of software production and recognise that tutoring software is a joint cognitive system involving a student, tutoring software and a human teacher whose involvement may be greater or lesser depending on the capabilities of the software and the manner of its integration into the curriculum. In such joint cognitive systems, it is more economic at times to increase a student's understanding of the tutoring software or let a human teacher handle certain aspects of the teaching than expend huge effort and expense in trying to design a comprehensive ITS that attempts to comprehend predispositions and mental processes of students with different personalities and backgrounds;

— to acknowledge that various educational technologies have their own strengths and that a learning environment benefits synergistically from an appropriate use of multiple resources and therefore the usefulness of any resource can only be studied in the context of systems employing it.

EVOLUTION OF COMPLEXITY

Achieving this level of complexity by designing it top-down is almost an impossible task, that is complicated further by the continuously evolving technology. It would, therefore, be useful to view the highly complex system as being made up of smaller entities which are networked—the connectivity producing the necessary flexibility and synergy. When this smaller entity has a degree of intelligence, it is an intelligent system of a lower order. It is hoped that when sufficient ITTs are ready, a second level of integrative tools will become possible. This integration can occur in two directions: vertical and horizontal.

Vertical integration in a Ranking ITT allows holding and comparing results of different instances of an ITT, for example, comparing four different investment proposals in the presence of a ranking factor like the investor's attitude to risk. Horizontal integration in a Linking ITT allows use of multiple tools to solve a given problem, for example, a Marginal Costing ITT providing contribution figures for maximising profit in a Linear Programming ITT. Thus, while a simple Linking ITT is a network of basic ITTs, it can be extended along the dimension of aggregation granularity to include other Ranking or Linking ITTs.

The advantage of this approach is that the necessity of interpreting complex interactions and the construction of complex feedback messages is eliminated. A student who has failed to grasp any of the intermediate steps drops to an appropriate granularity level where the simple feedback messages are adequate. The emergence of a higher degree of intelligence through connectivity is demonstrated by combining the ITTs with a teaching support tool (TST) like the Marker software which enables testing of a student's interpretation for an examination-type narrative question and allows the system to discriminate between correct solution, incorrect interpretation but correct method, and incorrect solution. An individual ITT is thus envisaged as an autonomous entity possessing rudimentary intelligence and then connected in a decentralised network enabling the emergence of a more sophisticated tutoring system. Even if this vision fails to materialise, the individual ITTs have their own utility and the total effort is not wasted. In order to appreciate better the strengths of an ITT, some aspects of their design are discussed next.

ARTIFICIAL INTELLIGENCE TUTORING TOOLS

An ITT is designed around a software engine which stores and processes knowledge rules. Its main features are:

a) a knowledge base containing the conceptual rules and processing information. It consists of two sections that together embed common didactic knowledge and domain didactic knowledge;

b) a student model which records a student's progress towards a complete solution. It contains four basic items:
   - values entered by a student;
   - value status; for example, differentiating a zero value because of a blank variable, calculated zero or data not processed due to an infinity condition;
   - status of the edit fields filled in by students, such as blank or intrinsically dependent (to begin with) and independent or dependent variable when filled;
   - user preferences of generative aspects of the interface; for example, in a Capital Investment Appraisal (CIA) ITT, students can choose whether the discount factors are given by the system, filled by using a 'Table' or calculated using a formula;

c) an *expert model* which links to the knowledge rules. This derives correct outcomes and records how they are derived. In the case of a narrative question, the local expert model is based on a student's interpretation of data while the remote expert model in the Marker software provides the correct interpretation—

their combination enabling *Marker* to assign a partial score for an answer based on a correct method but an incorrect interpretation of given data, demonstrating emergence of a higher degree of overall intelligence from the connection of the rudimentary intelligence of an ITT to the Marker Teaching Support Tool (TST);

d) a tutoring module which links students to the various parts of the engine through its user interface and gives advice based on the work done so far. It allows a student to adopt a different route to the solution than the expert model;

e) a user interface module which provides interaction between an end-user and various parts of an ITT;

f) a level selector which determines the functionality that is made available to a user through the interface. The levels are:

- the student level which allows the use of the ITTs for learning without being able to create examples for others to use;
- the lecturer level that enables instructors to create examples or templates for use by the students and to save model answers used by the Marker. Marking of students' assignment work is also possible at this level. An 'auto-solve' option is provided at this level that solves whatever it can as each independent variable is input to enable adjusting of inputs to obtain a desired scenario; and
- an administrator level in which the global management of marking schemes and students' data is possible. This functionality was subsequently taken out of individual ITTs and centralised in the Marker to enable summarised results over a number of ITTs.

g) set of enhanced features which embed functionalities such as:

- a *random question generator* which randomly picks variables and assigns random values within specified bounds and then derives the solution by applying its knowledge rules. Thus, an ITT need not contain any data bank and all students can get individual questions but a lecturer can create a bank of questions to be used by all the students, if so desired; and

- a *dynamic feedback system* that generates feedback messages dynamically based on the information received from a tutoring module. The software's advice to a student is based on the work already done by that student and what the student should best do next.

In the case of an examination-type question—given in a narrative form and requiring a student to interpret data, identify given values and derive a solution—the lecturer's model answer held on the Marker software serves as the overall expert model conveying the correct interpretation and the correct method while the application (local) expert model tests correctness of the method employed by the student.

The combination of remote and local expert models enables the Marker to give a partial score for an answer based on a correct method but a wrong interpretation of given data. This clearly demonstrates the emergence of a higher degree of overall intelligence from the connection of the rudimentary intelligence of an ITT to the Marker software. The implementation of applied artificial intelligence enables an ITT to generate random examples and assist students in solving them.

In the interactive mode, the software does not let a student enter a wrong value and provides immediate feedback, as found in a student modelling technique known as model tracing—the difference being that a student's outcome is monitored rather than the process (rule) employed. Such dynamic feedback is considered essential for learning as it prevents (at source) any incorrect mental associations being made by a student. In the assignment mode (which is meant for testing) there is no immediate feedback and the software allows any values to be entered. Feedback on their correctness is given after the work is marked.

STRUCTURE OF TUTORING TOOLS

Patel describes the variables on the screen as empty containers connected in a network of interrelationships. They represent an instance of their associated concepts. Any value can be entered in any variable, provided the whole network remains consistent. The intermediate variables need not be filled in. This approach allows mental calculations and does not force a rigid path to the solution. Provided the value being entered is correct, the ITT assumes the intermediate steps to be well within a student's conceptual knowledge boundaries. If the value is incorrect, then the ITT guides the student in a graded manner. This advice is not based upon some hard-coded set of instructions.

A student model is applied here to improve student learning. According to the terminology used by Self (1988), corrective, elaborative and evaluative aspects of the student model are used. The advice given by the software to the student is based upon the extent to which that student has been able to solve the problem so far and, in view of that, what that student should best do next.

The corrective behaviour of the software tells the students whenever they make mistakes in calculations. If they make a mistake second time, elaborative behaviour comes into action, which suggests the various relationships by which certain values can be calculated. The suggestion depends on what the student has done so far. If enough information is not available on the screen to calculate a certain value, the software guides the student to fill in other values before attempting to complete that particular value,

The evaluative aspect of the software is featured in the assignment mode, which is designed to assess the gain in a student's knowledge. Diagnostic, predictive and strategic aspects of the student model are not considered to any significant degree in the software, the reason being that the learning topic has been 'sliced' into such small modules that they become the most basic units of that topic. Coupled with dynamic feedback this paradigm keeps on reinforcing the correct connections throughout the network of interrelationships and eliminates the need for the above aspects.

INTERFACE DESIGN

The interface to the Byzantium ITT includes various features, such as:

- a context-sensitive help link to textual descriptions of topics;
- file and print management; and
- efficiency/learning support tools—which may be either general, such as an on-screen calculator, or application specific, such as the discount factor table in the CIA ITT.

The user-interface is mouse-driven and employs only push-buttons, scrollbars and edit controls, so as to make the interaction as simple and instinctive as possible. A push-button is also activated by a keystroke of the letter highlighted on its label. This allows for mixing the mouse and keyboard events to enhance a user's efficiency and comfort. All data entry is done through an edit control, suitably masked to prevent entry of illegal data.

The interface also reserves a certain area on the screen for interactive feedback, so users do not have to search the whole screen for the information that they require. As students prefer greater use of diagrams and pictures, graphical representation of data is provided wherever possible and the on-screen tutorial text is augmented with illustrations and replicas of screens.

FUNCTIONAL CONSIDERATION

The ITT accepts a correct entry, regardless of the state of the student outcomes model, allowing a student to carry out some operations mentally. It forces an intermediate step calculation only in case of an invalid entry—signifying that a student has not fully grasped the chain of relationships.

The ITT also provides support for decomposing complexity, that is, a student who is not confident about using a formula can call up a formula interface in the Capital Investment Appraisal module, which has the formula decomposed into its various constituents. A student can obtain expert help in filling each of the constituents and can work in stages to derive a result of that formula—in the context of the data to which the formula is to be applied. In the first level of integration, the ITTs are linked to Teaching Support Tools (TSTs) like the Marker mainly through the data driven programming paradigm, as each ITT, through its file structure.

BYZANTIUM APPROACH TO THE INTERNET

The development of the four diverse ITTs provided necessary information to formulate the methodology to construct a general purpose tutoring tool builder. The builder, and the interactive dialogue with a subject teacher, will produce the ITT for any numeric discipline.

The internet allows these knowledge entities, in the form of ITAs, to be held and accessed in a structured manner. With the appropriate structuring parameters, the ITAs created by different teachers build up to a large inventory of accessible knowledge that can be utilised by all the teachers in various configurations of single or multiple ITAs to suit more advanced applications.

The students will need to download the general purpose ITA modules only once, as they could be used by any ITA. In order to run each ITA, the students would need to download the appropriate ITA configuration file, created by a teacher and made available on the internet. The ITAs will enable students to use these tutoring tools interactively using standard web browsers while obtaining the same feedback and guidance as provided by an ITT.

The indexing of the ITAs would require an approach that is concept based where the ITAs are classified according to all the subject domains where they may find an application and may fall in more than one classification due to the overlapping of the concepts in various disciplines. The possibility of linking various ITAs in a configurable teacher designed ITS allows the extension of the ITT concept to more complex applications. However, the methodology could only be firmly established after more prototypes are built and tested on the internet.

12

Monitoring a CMC Environment

A programme on CMC (Computer Mediated Communication) environment with 110 distance learning students and nine tutors was held in United Kingdom and Europe. The participants were online for the duration of their course from February to October. To find out what essential characteristics make a successful CMC, data about the students who used the CMC to help with their study has been collected. The CMC was structured by an independent person who was called the Interactive Media Facilitator (IMF). The environment was also designed to facilitate exchanges in the following three dimensions:

- a knowledge dimension (including domain and meta-knowledge);
- a social dimension; and
- a motivational dimension.

The environment for M205-STILE comprised a number of areas which enabled the students to socialise, work in tutorial groups, consult with the course team, and access extra course material. For information on the IMF and how the conferences were structured. The data collected has been analysed in order to understand the nature of student participation in the CMC environment. It reports how the conferencing was used and presents a range of empirical findings which were designed to address the following questions:

- How did the students use the conferencing environment to help with their study?

- What were the student levels of participation in terms of the knowledge dimension, the social dimension and the motivational dimension?
- How did the tutors perceive their students used the environment?

In order to find out how the students made proficient use of the CMC environment to help with their study, a number of online questionnaires were analysed. These included: questions about how the students made use of M205-STILE; information about how the tutors expected the environment to be used; and questionnaires to ascertain the tutors' perceptions of how the M205-STILE environment was actually used. At the end of the computer science course, 58 students were still online, and 84 per cent of these students responded to an online questionnaire. Subjects reported one or more ways in which they used M205-STILE.

The following comments are selected from student responses, as examples to illustrate each of the 11 categories.

Help with problem solving

The students reported that M205-STILE was used mostly for problem solving. This could be achieved explicitly by posting a message and receiving a direct reply but also vicariously through scanning messages from other students.

Keeping in touch

Students wanted to keep in touch with other students and see what was going on.

Contacting tutors

Some students wanted to contact their tutors:

> ... about problems with coursework...

The extra course material

Students reported how invaluable they found the extra course material.

News and information

Students used M205-STILE to browse through the conferences for up to date news and information about Tutor Marked Assignments (TMA's) and general queries

Tutorial notes

The ability to download tutorial notes was important to students who did not have face to face tutorials, and those who worked away from home or travelled a lot with their work.

The M205-Help and Tutorial conferences

Access to these conferences was of great benefit to some students where they could have access to tutors in addition to their own.

Web access

Access to new technologies such as the Web was of interest to some students.

Online Chat

Online synchronous messaging was used by two students for private chats with fellow students.

Revision

One student responded.

The categories of problem solving, contacting their tutors, downloading tutorial notes and revision all could be considered as activities that promoted student understanding in the knowledge dimension. Although at the beginning of the course student interactions could be described mainly as belonging to the social dimension, at this stage, i.e., two-thirds of the way through the course, only two of the categories listed could be classified in the social dimension, those being, to keep in touch and online chat.

The motivational dimension proved to be a means of sustaining involvement and interest in the computer science course throughout the 30 weeks. Some subjects reported using M205-STILE to download the extra course material, and to participate in the help and tutorial conferences, i.e., to share their expertise with others and find out what others were doing. They also accessed the web, utilised the system to keep up to the minute with news and information about their course and even found help with other OU courses. It is suggested that all these latter activities belong to the motivational dimension of this computer conferencing environment. Looking at the framework grouping in terms of the actual student responses, it can be seen that the knowledge dimension seems to be the one used most by the students in the online environment, while the motivational dimension appears to be more important in the sense that there is more activity taking place here than in the social dimension.

Table 1

Activities in each of the three dimensions of usage of STILE

Knowledge dimension	*Social dimension*	*Motivational dimension*
Problem solving	Keeping in touch	The extra course material
Contacting tutors	Online chat	Help and tutorial conferences
Tutorial notes		News and information
Revision		Help on other OU courses

These preliminary findings deserve further investigation and it is planned to probe the interpretation in greater depth through an analysis of a number of case studies in which the activities of four students were followed throughout the course. This can be achieved by not only having access to the messages they posted in the conference but also by a series of in-depth telephone interviews recorded at six spaced intervals while the students were following their computer science course.

The tutors' expectations before the students were online

The tutors also suggested that students would profit from making explicit to their peers problems they encountered when trying to understand the proposed curriculum. They hoped that the sending of programme code, via e-mail would lead to a swifter response cycle and this quicker feedback would serve as a motivating agent. The tutors' initial expectations fell into three main groups. They predicted the system would provide an improved mechanism of delivery for course materials, assessment and information. It would be of pedagogic benefit through more student contact and would also be of motivational value. Examples of the tutors' thinking prior to their students using the CMC are as follows: two of the tutors hoped to have plenty of contact with students via FC, because they had students living in remote areas of Scotland where they could not attend face to face tutorials.

The latter tutor hoped to be able to pass problem code backwards and forwards. The benefits of this delivery mechanism were discussed by another tutor who mentioned it would be easier to solve coding problems because code would be visible. One other tutor focused on the benefits of this new delivery system and stressed the fact that students would be able to pick up tutorial notes when they could not attend face to face tutorials.

How the CMC environment was actually used

The students did indeed use the system in ways that the tutors had predicted for example highlighting problems, raising queries and sending programme code. The tutors' initial perceptions of how the environment was used fell into three basic groups, as did their final evaluations. However what is interesting is what was not predicted, which was an improvement in the quality and content of contact. One tutor said students were enabled to request further explanation of points in the course units, worked examples, etc., that were not understood.

13

A Digital Text

During the Second World War computers were developed to help military establishments in ballistic calculation, in military logistics and later in atomic physics. Computer technology was subsequently applied to research areas like computation of mathematical functions and resolving difficult problems in engineering. Commercial use of digital computers was first made by the aircraft industry and later by insurance companies. Computers in higher education were first employed for research in applied mathematics, engineering science and astronomy during the 1950s. The 1960s saw computer-based methodology employed in the social sciences. The introduction of database technology in the 1970s, while extending its use to other disciplines, helped make computers more cost effective.

Computer Aided Instruction (CAI) has been successfully applied to disciplines as varied as language and literature, biblical and religious studies, archaeology and history, as well as to teaching of ancient languages like Sanskrit, Greek, Latin, Egyptian and Sumerian. Marshall Mcluhan rightly called the computer a prosthesis in the assistance of human intelligence. A remarkable modern tool, it is indeed a powerful aid in the field of mental endeavour. The ongoing shift from Gutenberg to new modes of communication has left its mark on the universities especially in humanities since they are text-centred studies and the culture of laboratories and computers is alien to them. That digital electronic transmission has become an important means of communication cannot be denied.

Network systems today provide facilities for electronic mail, easy access to database, as well as opportunities for discussions and conference with colleagues from all over the world. It would not come amiss therefore to familiarise oneself with some commonly used terms in electronic communication systems such as hypertext, document assembly, multimedia and software innovations.

1) *Hypertext systems*: The hypertext system link different parts of a work so that one can jump around the same work and also in and out of other work as the need arises. It opens up a world in which it is possible to work with books always present to one another and to us. We can acquire detailed information on one point, refer back to a previous document, compare with a third and then switch back to the main argument.
2) *Document assembly*: The document assembly is a technique which enables work to be carried out in predetermined formats like order forms, invoices, application forms, etc. All relevant forms are available on file and can be used as and when desired. Facts entered in the forms at one point may be used to fill in the forms automatically at any other point. Thus a curriculum vitae entered once will appear on all forms as required without further processing.
3) *Multimedia*: The multimedia combines the use of diverse media. Thus a topic can be explored through text, video, music, graphics and other relevant modes. It can either be joined into one unit through use of hypertext or viewed sequentially.
4) *Software innovations*: The software innovations allow for both hypertext systems and multimedia presentations viewing. Windows displays have been developed where screen can be enlarged or diminished to make room for others involving text or other media.

Two major advantages of digitalisation are demassification and interconnectivity:

ii) *Demassification*: The entire contents of the *Oxford English Dictionary* can be conveniently stored on two thin CD-ROMs. Reading is not affected as the typeface can be limitlessly enlarged. It has furthermore been predicted that the ratio of data to matter will increase dramatically in the coming years.

ii) *Interconnectivity*: Storage of texts, images, sounds on electronic systems opens up unprecedented possibilities in higher education. Link ups with databases becomes possible throughout the country, and also internationally, thus leading to drastic cuts in inter-library loan expenditure.

In the electronic age the key nomenclatures are being recast. Traditional definitions for traditional institutions like the book, the author, the editor, the publisher, the reader are undergoing rapid redefinition. Thus in the work centres of the National Library of France (Bibliotheque National de France) readers are being redefined in terms of the reading they practise (long term versus short term readers). Earlier categories of social (learned and popular), political (public and private) or economic (fee paying and non-fee paying) are no longer valid.

The sundry problems which can be visualised in the process of electronic digitalisation are:

1) *Unaccountability*: The printed book imposed limits to acquiring a text and modifying it; a costly book had to be shared or borrowed and it was considered unethical to cut up or mark someone else's copy. But with the advent of the electronic revolution all such considerations are passe. Writing no longer retains its fixity. Without fixity signification becomes uncertain. Books can be infinitely reduced and modified without any guarantee that the purity of a text will be maintained.

2) *Control*: All control is removed from the hands of the originators of file contents. Interference is difficult to detect since it can occur at the speed of light without leaving behind any traces in the original document. An agreement therefore will have to be devised for the protection of copyright in a situation where virtually no control seems possible.

3) *Monetary considerations*:
    i) *Writers and publishers*: Publishers are motivated solely by the wish to make money. Authors need money but they also want recognition. A prerequisite of recognition is a wide readership. Thus begins a clash between authors who want a wider dissemination of text and publishers who do little to encourage use without payment building barriers to deny access.
    ii) *Users:* When a work is written primarily for information it needs to be used. Publishers claim that users must pay. Users do pay in the sense that they use the information received as starting points in their own work thus adding to the corpus of existing information.
4) *Economic viability*: The single most important factor behind escalating prices of the book is the spiralling cost of paper. Due to the scarcity of trees paper has become expensive and printing on paper is now a costly venture. Digitalisation will usher in a paperless society but it will require substitute materials. Conversion of documents into electronic media will be an expensive exercise. Initial investment in installation of access services and infrastructure will be heavy. Conservation and maintenance cost will be high. Therefore what is envisaged is a shift in expenditure rather than a real reduction in cost.
5) *Security systems*: Computer criminals, virus producers, saboteurs and hackers pose grave threats. Academic work is virtually accessible worldwide. No effective copyright laws exist. Banking systems, especially financial transactions, need to be protected. Access detection systems are still expensive.
6) *Modes of textuality*: Digitalisation holds out the promise of a limitless expansion of knowledge and our ability to access it but it ushers in a new mode of textuality different from that of the printed text. Whereas the digital text is a matter of immediate and continuous apprehension the book is a more leisurely and slower

form of expression. It is, as Marcel Proust has said, a fulcrum that creates space out of time. It gives us time to investigate, reflect and contemplate and is a rather slow and tedious path to knowledge and action.

7) *Validity of human experience*: The necessity to preserve the validity of human experience becomes the duty of every human being. In the electronic world human experiences threaten to be reduced to the status of a pure memory flow of an online exchange.

The electronic digitalisation is still a fanciful unreality for the majority in a country like India. Equipment is still too expensive, software scarce and power supplies, irregular. Lack of spare parts and components often makes it easier to replace than to repair. The ERNET, a computer networking project, set up as a joint venture between the United Nations Development Programme and the Department of Electronics in 1986, is still beyond the reach of the masses.

The total number of computers in India is comparatively small. Government statistics claim that there is one computer per thousand in this country. The Department of Electronics is targeting a penetration of one in hundred in the coming four to five years.

DIGITAL MULTIMEDIA

The computer, television and the telephone have today converged into a single access digital technology, and such networks in turn are leading to a high speed reliable and robust data communication network systems. This convergence is enabling interactive, self-directed participation to obtain services, products and information. By virtue of this convergence, we can have interactive TV, video on demand running on our computer screens, mailboxes which convert voice to digital or text form and back again, desktop video conferencing and a variety of electronic devices such as newspapers, shopping malls and financial reports brought to us via public networks.

Moreover, technology has migrated from analog (continuously variable signals) to digital (binary signals) steadily over the last two decades. This trend has taken place not only in telecommunications, but in the computer industry as well. On the one hand, the analog copper wire based telephone network is gradually getting replaced and augmented with fibre optic-based digital technology, namely, the Integrated Service Digital Network (ISDN). On the other, fibre optic networks have the increased bandwidth and speed required to move large amounts of digitised data from one point to another via computer systems.

The trend towards miniaturisation and the requirement for greater and greater storage capability was facilitated by the migration from floppy disc to read only memory compact disc (CD-ROM) which is capable of storing about a thousand times more data than a floppy disc and has become the medium of choice for distributing multimedia services.

MULTIMEDIA COMPUTER

The multimedia computer uses the normal output media of display screen, printed hard copy alongwith recorded high quality audio, high quality still images, animation or recorded motion video. The words recorded and high quality should not be overlooked—they refer to the capability of the multimedia computer to successfully display images, video or sound that has been captured from live sources, much like the capability of a television system.

Capturing from live sources is in addition to the computer's inherent ability to generate its own pictures or sounds through software, which we refer to as simulation. This emphasis on real or natural sounds and pictures is important for it greatly enhances the realism of a computer presentation; it tremendously expands the sources of materials that we can display or present within a computer. Now, in addition to signing our name on a document, we can use our own photograph or our own voice to sign. If we want to show a real object as part of our presentation, we can simply point a video camera at it and click a button to include that in our work.

ENTERPRISE MULTIMEDIA

Modern network capability has grown to the point where distributing multimedia via a digital network is now practical. IBM has articulated a concept, which they call enterprise multimedia, where every PC or workstation in an organisation is multimedia ready and the network and its servers can handle multimedia traffic along with the other data.

Multimedia objects can be stored at any server and made available to users of the network on demand. The enterprise multimedia concept depends on the use of all-digital multimedia. A hybrid analog digital system will not work with the digital network. An important possibility, once corporate-wide digital networks are in place, is to use the network for tele-conferencing. Each participant remains in his own office, but by means of a digital audio connection through the network, he can communicate with the other participants, regardless of where they are located. Using the other multimedia data types, such as video, graphics, images or animation, any participant can introduce illustrative material into the meeting to facilitate better communication.

ISDN FOR MULTIMEDIA

Integrated Services Digital Network (ISDN) is valuable for multinational corporations using data communications to connect international small to medium branch office local area networks (LANs). But ISDN is not just for internetworking LANs over the wide area; it can be used as a high speed, dial-up link to the internet and is well suited for the International Telecommunications Union (ITU)'s recently approved T.120 multimedia conference standards. It even supports video-conferencing.

Since ideas on what exactly constitutes a multimedia presentation vary, the standard allows equipment to support subsets of the specification. For example, two video teleconferencing units sharing a conference with devices that support only audio and still image, or audio only, must be able to work together at the most basic level of voice communication. The premise behind a multimedia teleconference is similar to video, in that groups can communicate effectively while avoiding the cost and time lost in travel.

The emerging applications of multimedia are the following:

1) *Training or education application*: The multimedia computer really shines when used for training or education in a one-to-one situation with a student. The multimedia presentation capability can show the student, material from any kind of source text, charts, audio, video, animations, simulations or photographs. When these are combined with interactivity, an effective learning environment is created. Multimedia training is also extremely effective in teaching someone how to use a computer programme and many recent releases of productivity and multimedia programmes include multimedia tutorials.
2) *Information delivery applications*: Many multimedia applications exist in order to give a user access to some class of data. Vast collection of data are in the form of books, catalogues, libraries, audio tapes, video tapes or still photographs. Any of these can be captured in digital format and presented by a multimedia computer; this is called information delivery and the other application is the CD-ROM disc.
3) *Merchandising applications*: Selling combines information delivery with other capabilities such as demonstration, quotation, negotiation, order taking and so on. The information delivery capability is an excellent front end for a programme that sells products. Authoring for sales applications is usually done by programming in an authoring language.
4) *Productivity applications*: Productivity applications such as spread-sheets, charting programmes or database programmes create screens that are displayed to show the user's data or calculations. It is valuable if the user can add multimedia objects to these screens so that he can use audio or video to support or explain his screens.
5) *Tele-conferencing*: The technologies of digital networks and multimedia promise to alleviate many of these problems through what is called tele-conferencing. With this, one can participate in a meeting without leaving

his desk or workstation and he can still obtain the kind of audio-visual experience he would get by travelling to a live meeting.

6) *Geographic information systems*: Management of facilities such as buildings, roads, power lines and railroad tracks is a problem that concerns government offices, utilities and many industries. Specially designed computer database management systems called geographic information systems are available to provide online support for these types of applications.

A truly interactive multimedia product can offer much more than television for entertainment, information delivery and education.

Multimedia enables a single user to interact with several applications; previously it was not possible to provide viewing and interactive capability to a number of users simultaneously and on demand.

Multimedia networking has provided the ability to dispense information to a wide audience—in office, school or home—in order to entertain, inform and train a large number of people in a uniform and consistent manner. In order to meet such objective, researchers have addressed issues such as speed and bandwidth of network server capabilities, capital investment in multimedia PCs, access to information systems and databases, custom-developed applications, cross-platform delivery and interactive as well as store-and-forward multimedia systems.

The major features of a multimedia system are the following:

1) The major front end of a multimedia is the audio which comprises an audio adapter, an audio input device such as a microphone, software to digitise the analog sound, amplifiers and speakers.

2) Rapid advances in video digitisation technology have enabled video to be harnessed and deployed on the desktop. Real-time video delivery, that is, delivering the presentation live requires a high-speed, high-bandwidth network.

3) Video-conferencing is another real-time video application. A video-conference can be point-to-point between two locations or multipoint, which can include several conference sites, depending on the system's capabilities. In several situations, real-time video delivery may not be necessary. In such cases a store-and-forward technology is adopted, in which a user can access a library of video presentations from his multimedia computer. The bandwidth and network speed requirements are proportionately lower.
4) Animation is another feature of multimedia capabilities. Two-dimensional (2D) animation is the most common type today, such as cartoons. However, 3D animation has mostly been confined to the engineering field like in computer-aided design (CAD). As 3D animation technology matures and becomes more competitive, this feature will also get into applications like online tutorials, simulations and virtual reality.
5) The Virtual Reality (VR) applications are programmes that could envelop a user within a 3D simulated environment of sight, movement, sound and possibly touch in the future.

There are four types of multimedia computer systems:

1) A multimedia application is best created on a developer workstation and viewed on an end user computer system deploying digital video capturing devices, minicomputer and studio sound system.
2) The multimedia on a desktop would be a low-end system suitable for viewing and interacting with multimedia applications called an MPC level 2 machine running at 25 MHz with at least 4 MB of RAM.
3) A multimedia kiosk system would be a computer system generally located in high-traffic area such as railway station, airport, restaurant or office. A viewer can interact with the system via computer running a multimedia application. Portable multimedia systems have been made possible through the revolution in wireless technology.

4) Portable computer systems such as laptops, palmtops and personal digital assistants (PDAs) are becoming smaller and lighter in weight, yet possessing considerable processing power, speed and storage capacity.

We will briefly look at three most important issues, namely, standardisation, privacy, and security issues.

— *Standardisation*: In order to enable fully flexible development, distribution and widespread deployment of multimedia applications, the most serious problem is the absence of a common international vendor independent standards.

— *Privacy issues*: The need for privacy requires that a user should be secure or protected from electronic access, intrusion and surveillance and still be able to interact with the system. It is also necessary that developers should take care not to invade in any way the privacy of people whose names, likeness and images appear in an application.

— *Security issues*: All electronic information is vulnerable to encroachment in some form or the other and organisations must prevent unauthorised access. Intentional or unintended abuse and accidental destruction of data can prove extremely harmful to the service provider. To gain access, the relevant staff must have the proper authorisation to view and interact with the application.

Multimedia offers immense potential today as well as for the future. Let us glance at just a few applications.

1) *Video on demand*: Video on demand is a user friendly method of providing video programming. The viewer decides when the programme will begin and not the TV company. The selected programme is instantly delivered to the user, right from the beginning. If someone chooses the same title a second later, it is delivered to that person also from the beginning. The same multimedia title can be viewed by any number of people concurrently, with each individual choosing his own viewing time. Currently there are several cable services offering limited video on demand.

2) *Entertainment*: Multimedia networking is probably used most of all in the entertainment industry, where applications are almost unlimited.
3) *Interactive television*: The Interactive Television (ITV) overcomes the drudgery of simply viewing the tube.
4) *Medicine*: Information about a patient such as X-ray, magnetic resonance imaging (MRI) scan, photographs, laboratory reports, case histories can be digitised and transmitted to the doctor anywhere anytime. Thus, specialists would not have to physically travel to examine the patient in rural areas where only basic networking equipment is set up to transmit via wireless communication to the hospital.
5) *Manufacturing*: Multimedia is growing more and more popular in this industry day by day. Touch-screen workstations assist the technician on the assembly line or in the production process and his queries can be answered by the system on touch screen by online video instructions.
4) *Retail business*: Many retail outlets are using multimedia computers as sales tools. The customer can have the product shown in a variety of colours and from which the buyer can see the preview of the play, the concert or the game from his chosen seat before actually making the purchase.

In future, it will be possible to link schools and other educational facilities by means of a highspeed, high-bandwidth data communication network in order to instruct and to learn online with greater facilities for indepth learning.

14

Virtual University Concepts

The university which supports its research/educational and administrative activities which leap over the boundaries of time and space can be termed as a virtual university. The idea of virtual university concepts include distance learning and virtual classes. This ideal educational development of virtual university is created by the support of infra information systems.

To implement infra information systems, the Centre for Advanced Information System (CAIS) at Korea Advanced Institute of Science and Technology (KAIST) successfully managed to develop the intelligent campus project and built all necessary infrastructures, that are mandatory prerequisites for the virtual university. On top of these infrastructures base at KAIST, CAIS has initiated the genuine virtual university project since 1997, and continues to explore the world of virtual university.

The CAIS at KAIST has continued its serial virtual university project research, with the knowledge acquired from the intelligent campus project for the last few years. The final products from the first year's studies on virtual university project are:

i) Essential information/integration technologies;

ii) Subsystems of virtual university information systems.

Researches and studies related to the essential information and integration technologies include:

i) Enterprise integration and object-oriented methodology under the client/server information systems environment;

ii) Management of CA (Certification Authorisation) in the fields of intranet/internet, server side script, and serial relations with Java and ActiveX technologies.

For subsystems of virtual university information systems, there are:

i) Administrative-supporting systems such as academic, personnel, financial, research, and work flow management systems;

ii) Newspaper scrap and online purchase management systems.

In the process of the development of the project, the usability within the environment of internet was emphasised, since we believed that the usability under the internet client environment, extendibility, and the upgrada-bility was the key trend of current system development. The project was proposed to import most advanced technologies, evaluate, and apply them to the process of information systems embodiment.

The main purpose of KAIST evaluation was to identify and remove all those unstable and risky factors that lie with the importation of new technologies, and to realistically apply those technologies to the information system that embodied at KAIST.

The virtual university information system model, the realistic product of this project, thus presents the maximised productivity and efficiency. The product of this project has been reviewed by other research institutions that proved the superiority of the product, and a few universities have already approved to adopt and customise the product as their information systems. Continuous upgradation and development, and integration of those systems seem to be necessary at this point, and we believe that continuous and serious dedication of every one of us is required to spread these technologies to other institutions, and to accelerate the development of information systems.

VIRTUAL UNIVERSITY PROJECT

The launch of intelligent campus project was mainly focused on developing infrastructures, securing database, equipping network and hardware facilities, and implementing basic communication and workflow systems on top of the cumulated database and hardware facilities. Sub-information systems developed are personnel, finance, academic, research, e-mail/BBS, workflow, and library automation system.

The virtual university project is instituted to reinforce the intelligent campus foundation by building virtual application systems on top of infra systems constructed. As with the completion of the project, we will be witnessing the Virtual KAIST that supports virtual education, research, and administration along with reinforced intelligent campus information systems.

The main goals of the virtual university project are:

i) To establish infrastructure-based application systems such as Electronic Teaching Assistant System, Integrated Workflow System, and Distance Learning System that will motivate virtual educational/administrative activities at KAIST.

ii) To achieve technical perfection in: (a) Client/Server Computing Technique (b) Object-Oriented Methodology Technique (c) Multimedia Technique (d) Database Optimisation Technique (e) Computer Supported Cooperative Work (CSCW) Technique (f) Work-flow Management Technique (g) ATM Network Support Technique (h) Effective Multi-casting Technique (i) System Security Technique (j) Effective Human-Computer Interaction (HCI) Technique (k) Internet/internet Technique and (l) Business Process Re-engineering (BPR) Application Technique.

The research issues of the virtual university project are following:

1) Enterprise integration under client/server information system.

   i) *Standardisation*: System consistency issue is to be carefully reviewed when developing applied systems. The Object-oriented Development Methodology has been studied to maintain system consistency and standardise interface, development module naming, and system architectures.

ii) *Integrating application systems*: To manage effective integration with legacy systems, the distributed logic system was applied. This application logic distributes system loads between server and client and consequently increases the effectiveness of resource management and system productivities, and lead to the usage of common database among different reusable client programmes.

iii) *Integrating interface*: A unified interface guideline was written to keep the pace with rapidly changing development tools' interfaces, in order to maintain consistent interface of our own.

iv) *Integrating data:* This is an important issue to implement system integration under distributed environment.

v) *Version control and system maintenance*: The primary issue for version control is to manage independent version upgrade between the integrated system and the infra systems that consist of the integrated system.

2) The intranet/internet technologies

   i) *Development of Certificate Authority (CA)* to intensify network securities.

   ii) *Application of Server-Side Script*: ASP (Active Server Page) to pursuit a utilisation.

3) Conceptualising virtual university and development structure definition.

4) Construction of virtual class infra structure, associated with the digital library.

5) Multi-casting technique that supports effective and real-time multimedia data transmission.

DIGITAL LIBRARY PROJECT

The major issues underlying the development of digital library project are the following:

1) *Legacy library data practices*: The legacy library practices were mainly focused on storing articles, audio and multimedia data into databases, but not properly utilised. Another issue is that traditional educational systems provide users with limited opportunities of education, in terms of time, space, and material diversity.
2) *Incentives to the development*: The new era of digital library request qualified and diversified utilisation of stored data, rather than the data storing itself. This need brings up the need of creative conceptual development of digital library. In order to be free from these limited time and space boundaries, the Digital Library Project attempts to support realising virtual education for every different set-up.

The initial approach to launch of the Digital Library Project was to establish the information infra and network within the institution, and to digitalise relevant data for active utilisation. The following approaches are to implement the electronic classroom model, creative and diversified hypermedia educational materials such as simulation or games, and complete application softwares' support, such as Electronic Teaching Assistant System.

The technical issues of digital library project are the following:

1) *Hardware needs*: The hardware system helps students and instructors, database servers to store materials, internet connections with other digitised libraries, wall display system, beam projector, computer presentation system, TV, audio/video system, video switching system, video camera and control system, satellite channel, ATM switch, ATM adaptor, and LOD and VOD server.
2) *Software needs*: The software systems to support and utilise hardware/infra, in addition to embodied infra systems, are like window white-board system, window sharing system, network file system, video conferencing system, distributed lecture supporting system, LOD management system, distance learning system, course-ware and hypermedia authoring tools, personal intelli-

gent tutoring management system, simulator, business games, electronic teaching assistant system, intelligent assignment management system, test and exam management system, grade management system, annotation system, schedule management system, group communication and authoring supporting system, LOD and VOD supporting system, internet TV system, library data retrieval system, and so on.

ERP PROJECT

For the development Enterprise Resource Planning (ERP), the need of Business Process Re-engineering (BPR) and underlying issues are:

1) Emerging need of fundamental structural and heirarchic changes.
2) *Various tools employed for managerial reconstruction*: Total Quality Management (TQM), KAISSEN, Just In Time (JIT), Continuous Process Improvement (CPI), etc.
3) *Business Process Re-engineering (BPR)*: BPR focuses to examine and radically change business processes—rather than business activity units—based on the utilisation of information systems.
4) ERP is to integrate infra information systems that support every single business activity and process, and effectively manage and monitor the corporations' business procedures.

Target products and expected effects of ERP development are the following:

1) *Development target*: The development target is to establish BPR and ERP implementation tool that can effectively segment and analyse multiple views of an organisation's business processes.
2) *Evaluation of the project*: The project will be evaluated by comparing the BPR supporting tool with other tools such as Business Design Facility (BDF) and Business Process Management (BPM), and by investigating the tool's effectiveness in integrating infra systems, in presenting user friendly analysis model, and in supporting resource process improvement.

MANAGEMENT INFORMATION SYSTEM CONSORTIUMS

The goal of management information system consortiums is to consult and provide organisations with advanced technologies that were acquired throughout the intelligent campus project:

The technical procedures are:

i) Examine current information systems of organisations;
ii) Inherit information system knowhows;
iii) Detailed consulting and establishing MIS development directions;
iv) Consulting advanced IT adaptation; and
v) Perform various cooperative projects.

The major workshops' issues for last 7 consortiums are:

i) BRP and business restructuring techniques and actual applications;
ii) CAMIS Client/Server Development Methodology and applications;
iii) Implementing Client/Server System and Distributed System;
iv) Design Techniques for Distributed Database and Systems;
v) Database Performance Tuning Techniques;
vi) Information System Security Techniques under Client/Server Environment;
vii) Server integration between Sybase and Data Search Server for data search;
vii) Applied Multimedia Techniques and ATM Network Plan of KAIST;
viii) Network Management and Internet Resource Utilisation;
ix) Software Process Management: ISO 9000 and Capability Maturity Model (CMM);
x) Researches on Decision Supporting System (DSS) Expert System (ES);

xi) Researches on Executive Information System (EIS) and Strategic Information System (SIS);

xii) CAMIS Enterprise Integration Module; and

xiii) Enterprise Resource Planning (ERP) Realising CAIS POP3 Gateway.

GLOBAL VIRTUAL UNIVERSITY (GVU)

The Global Virtual University (GVU) is a virtual university that exists in the cyberspace of the internet. It is a global university accessible to anyone, anywhere, anytime. It is concerned with the future. Its graduates will be professionals with global skills who can work internationally in an information society that will be a better place for their participation.

The strength of the GVU lies in a founding faculty of fifty internationally distinguished academics dedicated to radically rethinking the very nature of a university to match the needs of the information society. The GVU is not supported through any taxation system. It is a commercially based foundation dependent on the fees of its students.

The GVU courses are available to anyone with access to the internet. While much of the instructional programme is likely to be text-based, it is becoming possible to give lectures, seminars and tutorials on the internet using audio-conferencing, audio-graphic conferencing, and video-conferencing. The GVU will have a virtual reality campus on the internet which contain a virtual library, a virtual student union, virtual classrooms and virtual laboratories and a host of other facilities. It will be a place where students and teachers can meet as avatars.

The GVU responds to the forces of globalisation and aims to produce a cadre of international professionals with global skills. Globalism in education comes from seeing the content of a particular subject from the multiple perspectives of different cultures and countries. There will be no exclusion of students on any grounds of race, creed, nationality, gender, or age. Students create lifelong social and professional networks during their time at a university. Usually these are local or national in nature. The GVU will enable students to develop international networks. It will create professionals able to operate at a global level with contacts in many countries.

The default language of the GVU is English, but there are no restrictions on the use of any other language. The GVU will offer courses in any language for which there is sufficient demand. Negotiations are taking place to deliver the same course in English, Portuguese and Italian. This is not simply a matter of translating a course into another language. It means looking at a subject from the point of view of different cultures to seek its common essence.

The dominant medium for the GVU is the internet. The GVU is negotiating to have a number of centres around the world at places of outstanding cultural interest. These will be centres for GVU meetings and block courses where people from all over the world come together to study, research and play. Academic direction is on studies that relate to the emerging information society. This implies a focus on the future and on global skills. Special strengths are emerging in such areas as communications, education, translation, English, business and commerce, and information technology.

In a world of dynamic change, where too often what is taught and researched is dated before it can be applied, the GVU will be operative, seeking to understand the factors that will affect the information society in order to help shape it. The GVU was inaugurated by the Rector of the University of Bologna, the oldest university in the world and one that is responsible for the *Magna Charta Universitatum*, a declaration of autonomy and a commitment to the highest standards in teaching and research.

The GVU's reputation rests on a founding body of distinguished academics. It is they who take responsibility for academic standards and direction. Every member of the founding faculty is an internationally recognised author and academic and a prophet of the information society in their own country. The founding faculty can be compared to the editorial board of an encyclopaedia or a research journal.

Anybody can submit a course proposal to the GVU but it will require the approval of three members of the founding faculty for the course to be accredited.

The founding faculty is responsible for ensuring that standards are maintained which place the GVU at the front rank of universities. Anybody in any country can submit a proposal to teach a course under the aegis of the GVU and if it is accepted they will be remunerated according to the number of students it attracts. To be accepted the course must be world class and directed to a regional or pan-global market. The proposal will go to three members of the founding faculty for approval and if accepted will become a GVU course and be offered worldwide. Copyright of courses submitted in this way is retained by teachers who are regarded as GVU teaching faculty for as long as they are offering courses.

The GVU tries to attract students wanting a global dimension to their knowledge and skills. It is not for people wanting an easy degree. It is for thinkers, those who want to see if they have something special, are innovative, creative, fascinated by the future and the changes that we call information revolution. It is for the self-motivated autonomous learner who can be challenged. Age does not matter, but two kinds of students are envisioned. Those who seek to be skilled global professionals and those who seek knowledge for its own sake. Courses can be taken for qualification (FQ) which means the student is rigorously examined or not for qualification (NFQ) which means the student did not want to be examined.

With other universities, the GVU will create a virtual network. A number of universities have indicated that they would like to be associated with the GVU. Behind this is the idea of globalising university education through the international accreditation of degrees that are an amalgam of courses gained from different but affiliated universities who allow student access to each other's degree programmes via the internet.

The GVU will be a postgraduate university with a strong emphasis on research. Research will mirror teaching, seeking answers to questions about the applications of new technologies (e.g., the application of low-earth orbiting satellites, global information infrastructures, virtual reality, molecular machines and genetic engineering to such fields as education, translation, transport, tourism and commerce).

The special advantage that the GVU offers is its ability to put together international research teams to provide a global research perspective. The GVU will have a research journal on the internet. The founding faculty is the editorial board. The journal will publish doctoral dissertations which will be open for inspection and critique by the global academic community. In this way it will establish and advertise the standards of the GVU and attract those who feel they can match the doctoral requirements.

The GVU is governed by a Board of Directors. The Board is composed of a Chairperson, a Secretary and a Treasurer and equal representation of the founding faculty and commercial involvement. It is fundamental axiom of the GVU that the academic and commercial forces involved in its development must be equal. In this way there will be a creative tension between academic purpose and commercial sense.

Through the founding faculty, the GVU is currently seeking to affiliate with universities around the world and with professional international organisations. The GVU has a founding faculty of 25 distinguished names, a management team of 25 and extensive experience of delivering courses on the internet. Master's level courses in Teletranslation, Corpus Linguistics, Global Communications and Education on the internet are under development. A Ph.D. programme is ready to be implemented.

The GVU will exist on the internet. It will conduct courses and research and be administered and managed and have a social life on the internet. Yet it is also intended that its courses should be made available at conventional universities and that centres will be established where students from many countries can come together in a place of culture and conviviality.

MICHIGAN VIRTUAL UNIVERSITY (MVU)

The Michigan Virtual University (MVU) was established in 1998 to meet the specific workforce development education and training needs of Michigan businesses and industries and their current and prospective employees through the innovative use of electronic learning technologies. The MVU was founded by Michigan Governor John Engler and the Michigan Jobs Commission in collaboration with several major industries in the state.

The MVU is governed by a board of directors comprising representatives of the Michigan employer community, educational leaders, and representatives of the Michigan Economic Development Corporation. The MVU was started with an allocation from the Michigan Strategic Fund. In addition, the MVU will generate revenues through fees, grants and contracts with strategic partners.

The MVU will not develop courses; instead, it will broker through the state's colleges, universities and private training providers. It will not grant degrees; instead, credentials will be granted by the organisation providing the programme. The primary motivation for creating the MVU was to provide high-quality, convenient, and cost-effective education and training to Michigan's current and prospective employees.

Educational institutions' involvement in the MVU will provide access to:

1) Resources to support the preparation of students for work and continuing employment.
2) Resources and teacher training to assist in the transformation from traditional classroom instruction to learning that can occur any time, any place.
3) Continuing research on industry employee training needs and distance learning best practices.
4) Statewide, national and international markets.
5) Collaboratives and cost efficiencies.

THE NEW JERSEY VIRTUAL UNIVERSITY (NJVU)

The New Jersey's public and independent colleges and universities get permission from the Higher Education Technology Infrastructure Fund to accelerate their long-range technology plans and increase their capacity to make higher education more accessible and convenient through distance learning. In the summer of 1998, Governor Christian Whitman called for the creation of a New Jersey Virtual University that builds on this increased capacity.

The New Jersey Virtual University (NJVU) demonstrates how the state's colleges and universities are fully integrating technology to meet workforce training and education needs, as well as the needs of a steadily growing number of high school graduates and adults seeking lifelong learning opportunities.

In January 1999, the first phase of NJVU launched, providing a user-friendly index of over 1,000 credit and non-credit courses offered via distance learning by 42 participating public and independent colleges and universities in New Jersey.

The index include over 40 complete certificate and degree programmes at the undergraduate and graduate level. Each of the courses and programmes in the virtual university index is offered under the jurisdiction of an individual college or university, which is responsible for all aspects of its distance learning offerings, including the granting of credits, certificates, and degrees. The index allows users to search for desired courses or programmes by institution, subject area, mode of instruction, or other criteria. It enables users to combine criteria to locate the precise offerings that best meet their needs.

The index also enables users to link directly to an institution's distance learning web page or online catalogue for specific information regarding courses, admission, registration, cost, and other facts about the institution.

The courses and programmes offered by New Jersey higher education institutions respond to the needs of a diverse population of learners requiring flexible timeframes and convenient ways to access education. As an outgrowth of NJVU, a number of community colleges already participating in the virtual university initiative have joined together to form the New Jersey Virtual Community College Consortium (NJVCCC). Students at any participating community college can register for the shared online courses offered through the consortium.

In September 1999, the next phase of NJVU was launched, which focuses on the quality of distance education in New Jersey. It includes an online Faculty Centre that serves as a clearing-house for materials promoting teaching and learning using instructional technology. The new NJVU website also includes general information about quality in distance learning and information about different types of distance education to help users determine what delivery methods might best meet their educational needs. It includes an interactive questionnaire to help potential students assess whether online courses are right for them.

The quality of distance education is the focus of a three-pronged, faculty development initiative proposed by Governor Whitman and supported by the Legislature. The programme will provide hundreds of faculty members with the skills and knowledge to effectively use online technology to enhance teaching and learning.

EURO PACE 2000

The Euro PACE 2000 is a trans-European network of universities and their partners in education and training, i.e., private enterprises, regional and professional organisations and public authorities. Approximately 60 member organisations participate in this network throughout Europe. Through the use of different models Euro PACE 2000 demonstrates and develops the potential of telematics for the European university of the future and thus contributes materially towards the realisation of the concept of lifelong learning.

CLYDE VIRTUAL UNIVERSITY (CVU)

The Clyde Virtual University (CVU) comprises the lecture theatre containing web-based course-ware in a number of subject areas. For copyright reasons the course-ware is only available to users on Clyde Net Metropolitan Area Network. The library holding CVU related material, links to physical libraries within the Clyde Net Institutions and course-ware covering information and study skills. At the CVU assessment hall, students can take online tests either as part of an interactive course-ware module or as stand-alone summative assessments.

CUX VIRTUAL UNIVERSITY

The Corporate University Xchange (CUX) and New Jersey Institute of Technology (NJIT) have announced a partnership to benefit organisations with corporate universities. NJIT has agreed to offer its world-class Webmaster Certificate programme delivered via the web and CD-ROM to members of CUX for a discount tuition fee. In addition, Corporate University Xchange has agreed to produce a conference for the community of Webmasters who attend the NJIT programme.

The first conference event for Webmasters was scheduled for the fourth quarter of 1999. This was the first of many partnerships between Corporate University Xchange and institutions of higher learning as the company expanded its mix of products and services to include world-class accredited online certificate programmes.

The CUX Virtual University Webmaster Certificate programme is composed of three online modules: (i) Web author (ii) Web developer (iii) Website manager. Each certificate is worth 3 CEUs. Unique to the Webmaster programme is the option for graduates to join a webmaster association and receive new content on a quarterly basis, as well as have the opportunity to attend live events produced by Corporate University Xchange.

VIRTUAL UNIVERSITY PROJECT AT UMKC

In July 1996, with a grant to two academic units—the Conservatory of Music and Computer Science Telecommunications—the Virtual University project at UMKC started. The project's goals were to build an infrastructure for course delivery and to prepare courses from both departments for online delivery. The unique characteristics of the internet make it a compelling option for delivering education and training. The internet not only allows a level of interactivity not available in any other medium, but also integrates all other media options. Hypertext allows the author to make explicit relationships between words and concepts in the same document and with information around the world.

THE MINNESOTA VIRTUAL UNIVERSITY (MNVU)

The Minnesota Virtual University (MnVU) is having more than 85,000 courses from many public and private education providers in Minnesota. The courses on a great variety of subjects delivered via the internet, satellite TV, or on-campus classrooms.

VIRTUAL CLASSROOMS

System Structure

Old Dominion University (ODU) has amassed considerable experience in this area through TELETECHNET, a remote instruction system which connects the main campus in Norfolk, Virginia, to several satellite campuses, 23 community colleges throughout the state and selected industrial and government sites. Over 2,000 students are enrolled in TELETECHNET. This current implementation uses broadcast satellite technology with terrestrial audio feedback from students.

Overview of IRI (Interactive Remote Instruction) Functionality

IRI supports both audio only and video/audio student participation. Up to two student videos can be shown to all workstations. Since any student can take control and demonstrate using the shared tool, IRI distinguishes between the instructor role and the presenter role. Presentation can be done at any site, but overall management of the class is under the instructor's control.

Thus the instructor can call on a student, take control of a tool away from a student and can initiate start up of a tool. In addition to off-the-shelf X tools, ODU has developed a set of shared tools which takes advantage of the IRI architecture to improve performance and interactivity in the classroom. It has built an efficient slide presentation tool which downloads all slide materials to the site file servers before the class starts to reduce network traffic during class. This package allows random or sequential forward or backward access to the presenter's slides. It supports multiple slide groups.

Students can also take notes online using a multimedia notepad. Any image on the screen can be snapped into the notepad and annotated, text can be typed either directly on the snapped image or into a separate text window attached to the image by a hypertext marker. One mode of interaction which is well supported by a distributed computer-based classroom is electronic polling. Using a survey tool, the instructor can ask a multiple choice question to the class at any time. Responses come back (anonymously at present) to the instructor's workstation and the results are displayed as they come in.

The instructor can use the results to assess the level of the class's understanding of a topic or to survey the class. The results can be broadcast back to the student workstations at the instructor's discretion.

TEACHING WITH IRI

A prototype of the IRI system was used during the fall 1995 semester to teach a graduate level course in Software Metrics. The class was taught in two classrooms, each with its own ethernet LAN. A third LAN network used by the system developers was also included in this evaluation. These three networks were interconnected with an ATM switch to simulate a wide area network. Use of M in this course forced us to face many issues in logistics, reliability, performance, and usability. In this course three issues were focused: presentation, feedback and interaction. Because of the multimedia capability of IRI, the instructor needs to develop a method of orchestrating the presentation. Not only is the material presented from diverse sources, it may be desirable to show several sources of information at the same time and to comment on them. Naturally, managing these diverse information sources and keeping the student focused on the current source of interest requires new functionalities in the interface. One method of keeping a student's attention is to annotate concepts shown on the computer screen using the public annotation tool described previously.

A second method for focusing students' attention was implemented during the course of the semester, referred to as the 'Global Pointer'. With the Global Pointer, the presenter can move an arrow anywhere on the screen to point at the item of current interest. Again we use the mouse for this purpose. As with drawing annotations, it implies that the mouse must serve two purposes: it must act as both a presentation aid and a selection device. Thus the purpose of the mouse is overloaded and can lead to confusion. It is planned to add a separate stylus pen for these purposes to see if this proves beneficial. Feedback from the students is a second area on which there is focused. Because of the network and workstation response times, feedback takes on new meanings in IRI.

Thus, not only are they in ODU interested in whether the students are understanding the material being presented, but they are also concerned about whether the material they have selected has reached all the students. Congestion in the network, load on the workstation and, in the extreme case, failure of part of the system, means that the presenter cannot be sure that the information shown on his/her screen is available on every other machine. In fact, the issue of information synchrony goes deeper since students can change their screen layouts possibly hiding the information the instructor wishes to present.

The design of the second version of IRI reserves some of the computer screen for private activities and incorporates voice annotation, off-screen capture of instructor's material to minimize the need to share the screen between private and shared use. The traditional forms of student feedback are supported in IRI in the following ways. This window contains a small picture of each student's face for a visual reference. When a student has been selected this way, his/her video will appear on every workstation in one of the two windows available for this purpose. This student can then use the microphone to hold a conversation. Furthermore, any student can get the instructor's attention and enter into a two-way video/audio discussion.

Students can also quickly interject an audio comment or question by pressing the audio button and speaking into the microphone. This fast audio-only mode half way through the semester to increase the spontaneity of verbal interaction. Another capability added during the semester was a survey tool. Using this tool, the instructor can ask a multiple choice question to all students. Each student can respond with a choice.

A running total of responses is available as the answers come in on the instructor's screen. This facility can be used by the instructor for polling the students in order to assess whether they understand the material being presented. Student interaction is increased in several ways in addition to the survey tool discussed above.

The two videos provide a visual focus of attention during student discussions which is not normally provided in distance teaming environments. Perhaps the most interesting feature of IRI for increasing interaction· is the ability to collaboratively manipulate shared tools. This facility allows the students to respond to detailed and complex tasks by demonstrating their understanding using a computer simulation, analysis or presentation tool.

Students can pose their questions in terms of this shared computer model and can show each other different ways of looking at the same situation. This capability in the Software Metrics class in order to foster a discussion about the concept of 'Lines of Code'. For homework, each student wrote a programme for counting the number of lines of code in any Pascal programme. During class, they ran their programs over a sample programme. The class discussed differences in the answer and even showed their solutions to the class for group analysis and discussion. It was even possible to propose new solutions to the problem and demonstrate them during the class. This kind of flexible interaction would have been difficult to achieve in any other classroom. From the student's perspective, IRI has several limitations and many advantages. Through our experience with TELETECHNET, an acceptance of remote instruction was found both for its increased availability and for the quality of the preparation of material. IRI extends TELETECHNET, making it possible for students to exercise more control.

However, this requires additional training for the students. For example, they need to learn how to be effective 'telecommunicators'. It was also found that poor performance is not only irritating but can make the system unusable. One of the advantages of IRI is the ability to take snapshots of the presented material and annotate it online. IRI can be compared to other modes of lecture style instruction along several dimensions which we discuss below.

In this discussion we contrast IRI with the traditional live class, remote instruction using a TV signal and a classroom equipped with modem audio/video presentation systems.

Presentation bandwidth: The amount of visual information, provided by the instructor, to which the student has access at any one time in the lecture. We feel that the ability to look back at material presented earlier is important in helping the student understand the lecture.

Student Demo: The ability for any student to show their work to the rest of the class. A student can go to the blackboard in a traditional class. In a TV class, remotely located students do not have the ability to demonstrate to the rest of the class unless transmission facilities are available at each site. In a modem AN class students may have limited access to the multimedia presentation system and most likely they would use a blackboard.

Spontaneous access to information: The ability for the instructor to refer back to material previously presented (perhaps at an earlier class) or to bring new material into the presentation that was not previously planned. While the instructor can bring previous presentation material to the TV and A/V class, the system does not explicitly support access to this material. In IRI this material is immediately available for access and, in addition, the instructor can access any material available on the network on demand.

In-class, out-of-band learning: This refers to the ability for a student to enhance a learning experience by means of a channel different from the instructor's presentation. While students could also read a textbook during the class, we do not count this if the system does not explicitly support this activity. Parallel learning refers to the ability for students to engage in a learning experience with others while the instructor is lecturing.

Instructor feedback: The ability for the instructor to discover if the class is following the material. Traditionally this is accomplished by asking questions. IRI allows anonymous surveys which offers new opportunities for evaluating the level of understanding in the class.

Training: Any additional training required beyond the traditional class as a baseline. IRI is the most demanding of the instructors and students in this regard.

Replay: The ability to review a lecture. This is important for students who miss a class or to review for a test. We assume that in the A/V class, the instructor can make available a copy of the presentation material (particularly easy if prepared electronically).

Engaging presentation: The ability to keep a student's attention during the class. In the TV class and in IRI, the ability of the instructor to use gestures and motion to act out the material is limited, although cameras which automatically track a moving speaker are available. Much of the interest in these classes comes from the media used for presentation. Computer animation using simulation or demonstration can be particularly effective in engaging students.

LESSONS LEARNED

Based on experiences with the prototype IRI described above, is being built, a new enhanced version which is to be used for teaching courses at the main and satellite campuses of Old Dominion University and at selected community colleges. This version represents an extensive redesign of IRI in order to reflect lessons learned. The major new features of the enhanced system include:

Administrative interface: An interface to help manage both the set up of the IRI network (which workstations are part of the class, which are audio servers, etc.) and for class management.

Lesson planning: This allows an instructor or student to specify which computer tools will be used during the class and the start-up parameters for each tool. All tools entered in the lesson plan are automatically started before the class. During the class, a lesson plan tool bar is displayed at the side of the IRI interface and the presenter can click on any tool to make it active.

Less intrusive note taking: Because of the limited screen real estate, there is a conflict between student use for note taking and public presentations. In the present system the student notebook competed with the instructor's presentation for screen space. In the new design, students can each open a small text window for continuous note taking in the bottom right-hand corner. In addition, they can snap an image of the instructor's material into their notepads. Also, students can take audio notes using a microphone.

Clearer separation of private and public functions: Along with the design of a less intrusive notebook, the new interface clearly separates those features which are for private use by a student or faculty and those which are shared by everyone. All shared material is placed in the lesson planning tool bar on the left side of the interface and all private functions are in the bottom tool bar.

More spontaneous interactions: Students can interact more quickly by clicking the mouse on any shared area that they wish to use. Normally, in free flow mode, this action grants access to a resource. For example, to display a video image of themselves to the class, a student simply has to click on the video image window. Similarly, to gain control of a shared tool, the user just clicks on the tool window; to access the global pointer, click on its image, and so on. All microphones are connected to audio energy detection software so that a student can request the audio channel merely by speaking.

Simpler interface: Many of the changes described above result in a much simpler interface for student users of the system.

Shared experience feedback: One of the difficulties with using IRI is not knowing when, and if, your audience is in 'sync' with your presentation. In the old IRI, the instructor would often start talking about new material as soon as it appeared on his/her screen without realising that many of the student screens had not been updated. Feedback information has been added into the communications software so that the status of student workstations is fed back to the presenter through the use of a per cent completion scroll bar. Performance has also improved by pre-starting all tools in a lesson's plan and downloading class slides before the start of a class.

Virtual Summer School

The School for D309 is a one-week summer school which gives the students a chance to gain hands-on experience of running experiments and developing an Artificial Intelligence programme. The students are also able to communicate with tutors and other students.

The students work in groups and, during the summer school, they complete two projects, one of which is then used for their TMA. They have a choice of projects from: Memory, Language, Artificial Intelligence and Problem Solving. All the projects, except for the Artificial Intelligence project, involve designing, running and analysing the results of a conventional psychology experiment. In contrast, the Artificial Intelligence project involves students creating a programme using the programming language PROLOG, which simulates an aspect of human reasoning.

The students have access to computers which run PROLOG, a statistics package, word processing and software for presenting experimental stimuli. There are also a variety of other resources for students to use while running their experiments, and background papers and books are available for students to use for their research. The students spend the first day attending introductory sessions on the four subject areas and then have to choose two projects to work on. They work for approximately two days on each project, and at the end of the projects, there is a plenary session where students present the work that they have done. Throughout the week, a variety of seminars are held in the evenings on topics related to the course.

Summer School is a compulsory part of the course, but even so, every year about 10 per cent of the students cannot attend. These students are given excuses for a variety of reasons, but normally because they are the sole careers of young and/or disabled relatives. These students complete one project at home with the help of their tutor and they are supported in this by a special paper-based pack for excusal students. In the summer of 1994, a pilot Virtual Summer School was run for 12 excusal students. These students were selected from all excusal students on the grounds that they would be very motivated to complete the Virtual Summer School.

The Virtual Summer School was designed to replicate the structure of a conventional summer school, but also included a three-week warm-up period which was designed to familiarise the students with the technology and software. The activities included making their curriculum vitae available and communicating online with other students and tutors. They then spent a week on each project. The students did not have a choice of projects as they do at the conventional summer school and completed a project on Language Understanding and Artificial Intelligence. The students were given a 'Getting Started' video to help them with setting up the hardware and contacting the Open University.

The students were supplied with a low-level Apple Macintosh, a modem and a mobile phone; the latter being necessary because their existing phone line was to be used to communicate via a modem. It is not possible to describe these resources in detail, but they enabled the students to communicate with tutors and other students, synchronously and asynchronously, attend tutorials and lectures, run experiments and analyse the results using Statistics, programme in PROLOG, word process, use the World Wide Web, receive papers and attend plenaries.

The students had access to the Macintosh Basics Tour as supplied by Apple to provide a basic introduction to the Macintosh and Guided Tours developed using MacroMind Director. The latter gave the students an overview of the summer school and the activities they would perform. There were also demos which recorded actual use of the software with voice-over sound tracks that describe how to use the software. The First-class conferencing package formed the backbone of the communication between students and tutors. The Virtual Summer School was successful: the students could use the technology and staff at the Open University were given the means to support the students technically, academically and socially. One student dropped out during the second week of the projects.

The project work that they did during the summer school was assessed by experienced tutors who said that the quality was comparable to that of a conventional summer school and all the students completed their TMAs. Their marks were similar to those of conventional summer school students.

EVALUATION

The evaluation was from a variety of perspectives including the students' work, the students' feelings, the students' use of hardware and software, the tutor teams' views and organisational factors. In order to carry out the evaluation, the students were given four questionnaires over the period of the summer school and a diary of their use of the hardware and software. They were also interviewed and tutors' opinions were gathered.

The students' projects and TMAs were also assessed and comparison data was obtained from conventional summer school students. There were 11 female students and one male, nine students had excusal because of family obligations (e.g. disabled child), two students had excuses on health grounds and one could not get time off work. The majority of students did not have significant computer experience, Two of the students used computers more than once a week, one used them once a week, three used them once a month and six used them less than once a month.

When asked about their expectations of the Virtual Summer School, the following was a typical response, although many students also added that they were looking forward to being involved in an experiment which may help future students.

The students found it difficult to pace themselves and some students spent up to 10 hours a day working at their computers, communicating with other students and tutors. As the following quote illustrates, this had an effect on other areas of their lives.

However, most students said that they had gained a better understanding of the subject, enjoyed the interactions with other students, improved their knowledge of computers and been encouraged to begin their revision. Some students found working in groups difficult, but this is often the case with groupwork and similar problems occur at conventional summer school. It is not surprising given that these students study on their own during the year and had the additional difficulties of coping with a new mode of communication.

Some students found that the technology got in the way of their communication but for many the communication was very important and made a significant difference. The students were asked how easy it was to use the software and hardware and the only significant problems were in initially connecting to the Open University. The results of the four questionnaires also show that students gradually found some of the software easier to use.

The results are shown in Table 1 and it is clear that the students rated first-class easier to use at the end of the summer school in comparison with their ratings at the beginning of the summer school. Virtual Summer School students and conventional summer school students responses to a question about the support that they received from the staff. There is no significant difference between the ratings and therefore the technology does allow staff to support students at a distance in the same way as staff support students when on a campus.

Table 1

Students responses to "How easy did you find it to use firstclass?"

After the warm-up	2.45
At the end of the course	1.30

Students were asked how effective they thought their time spent collaborating was, both at the Virtual Summer School and at conventional summer school. There was a significant difference (Mann-Whitney U = 891, $p < 0.005$) between the groups of students, with the Virtual Summer School students saying that the time spent on collaboration was less effective than the conventional summer school students.

Table 2

Responses to "Do you feel you have had enough support from Open University staff?

Virtual summer school	2.81
Summer School	3.10

This shows that although the technology effectively allowed staff to support the students, the technology interfered with the ways in which the students worked together as groups. Table 4 shows the results for the different projects. There is a significant difference between the two sets of ratings for the Artificial Intelligence project, (Mann-Whitney U = 108, $p < 0.02$), but no significant difference for the Language Understanding project.

Table 3

Responses to "was the time spent in collaboration on the projects an effective use of your time?"

Virtual summer school	2.83
Summer school	3.69

It is not possible to determine exactly why there was a significant difference between the ratings of the two groups of students for the perceived effectiveness of the collaborations on the Artificial Intelligence projects, but not for the Language Understanding projects. This may be as a result of differences in the nature of the two projects and the use of the technology for communication.

The Language Understanding project involves deciding on a suitable topic, designing the experiment, running the experiment and analysing and interpreting the results. These sub-tasks can be carried out independently once the experiment has been designed. However, in the Artificial Intelligence projects, the students do not have as much choice about what they are going to do, and there is only one activity which is creating the programme in PROLOG.

Table 4

Responses to "was the time spent in collaboration on the projects an effective use of your time?" for the two projects

	Artificial intelligence	*Language understanding*
Virtual summer school	2.27	3.33
Summer school	3.54	3.84

The students cannot work on different aspects of the programme on their own and need to understand the evolving programme as they work. Thus the Artificial Intelligence project relies on students working together at all times and communicating effectively. There were four members of staff involved in the teaching on the Virtual Summer School.

However, it is clear that the students appreciated the effort that the tutors put in to helping them. One of the problems for staff was that since the technology supported both synchronous and asynchronous communication, some students got left behind. Students could not always follow all the communication that occurred and some students fell behind the rest of their groups. This meant that they could not work effectively as a group.

VIRTUAL EDUCATION INSTITUTIONS

The future of education in the world seems to be under attack in ways that ultimately will affect the overall quality of life for everyone. Nations must recognise that their human resources are their most valuable resources. Most developing countries are unable to produce engineers and technicians in large scale due to many reasons. There is also an urgent need, because of the high-tech revolution, to retrain and upgrade the engineering workforce already available in the country.

The conventional methods of teaching and educating engineers and technicians cannot cope with the scale and magnitude of these needs. A number of new initiatives have been taken recently with the main objective of making engineering education not only cost-effective but also accessible to a large number of people. These new initiatives are based on satellite delivery of courses from one location to another locations simultaneously.

The magnitude of increase in industrial human resources required in the engineering workforce cannot be achieved by conventional educational system for many reasons:

1) Conventional classroom teaching methods are based on a staff-student ratio of normally 1 to 10. A substantial increase in intake into technical education institutions would mean substantial increase in the faculty strength.
2) Even if it is possible to train faculty in sufficient numbers, most of these faculty members will be inexperienced for a long time to come. Students would not have the benefits of teaching by experienced and expert academics.
3) There is a need for a well-stocked on-campus library facilities. Libraries in most developing countries have collection of obsolete materials. Lack of sufficient funds hinders acquisition of uptodate books and journals.
4) Providing effective practical training in technical fields requires heavy investments in laboratories. Most states are unable to make the quantum of investment

required. There is very little maintenance and servicing of equipments.

5) Another problem is with the retraining and skills upgrading of existing technical manpower. To keep up with the rapidly changing global environment retraining and education have to be lifelong. Lifelong education is not possible as it will take engineers away from their workplaces every time.

6) Engineers of today are to be global in skills, attitudes, and ability to be able to participate productively in the current environment of globalisation of economy and the information technology revolution. Internationally marketable skills, global thinking, and the ability to respond to the rapidly changing global environment can be imparted only by a curriculum that has a global character and by programmes which have inputs not just from a team of local experts but from a team consisting of best experts from around the country.

A number of initiatives taken very recently are good examples of the alternative approaches to technical education. These initiatives demonstrate the potential of these approaches for large-scale generation of technological human resources.

— *National Technological University* (NTU): The NTU was established in Colorado, US, as a non-profit corporation in January 1984. NTU was the first institution to use satellite-based delivery of instructions on an expansive scale. It offers a wide range of ITV courses through satellites to a large number of sites in the US and the Pacific Rim Countries. The course are taught by top faculty from 47 participating leading engineering schools in the country. Starting with 33 courses from 13 participating universities in 1984 the NTU programmes have grown into more than 1,300 courses from 47 participating universities. In 1995-96 NTU offered through satellite broadcasting more than 22,000 hours of credit instructions and 3,000 hours non-credit advanced technology and management programmes.

— *African Virtual University* (AVU): The AVU project grew out of the desperate need for mass tertiary education in science and technology in Africa. The UNESCO is promoting the concept of satellite-based universities in science and technology in four regions of the world—the Arab States, Eastern Europe-Central Asia, Latin America and Africa. The programme proposes, among other functions, to technological and scientific human resources base in Africa, if the continent is to participate in the global economy and seize the opportunities created by globalisation of economies and information technology revolution.

The AVU will be unique in the role it will play in the economic and social transformation of Africa through mass tertiary education in science, technology and management. While NTU brings the education and technology to the doors of the professionals who need training and education, the technology is already available within the country. In the case of Africa, the AVU will play a big role in transferring the technology from the developed world to Africa at least in the initial stages until such technology and technological expertise are available within the continent.

UNESCO AND SATELLITE UNIVERSITIES

UNESCO is promoting the concept of satellite-based universities in science and technology in the Arab States, Eastern Europe-Central-Asia Latin America and Africa. The programme proposes among other functions to:

i) Develop a core group of universities in the region committed to developing and offering programmes in science and technology via satellite throughout the region;

ii) Select a few of the core group as initial uplink centres for delivering procured scientific and technological education material; and

iii) Establish international links with leading universities in the US and Europe for sharing knowledge;

Some of the end objectives of the programme are;

i) Increasing the skills and capabilities of scientists, technocrats, professionals, and managers by providing them opportunities for professional development in their workplace through ITV via satellite;

ii) Supporting present national and regional network of open universities; and

iii) Increasing public awareness on the importance of science and technology.

Today, the picture has altered. Education, just like health care, is undergoing a revolution in the US. For-profit institutions are expanding at a great rate and old ideas about profit and non-profit are being challenged. Today, the fastest growing university in the US is a for-profit organisation.

VIRTUAL REALITY IN EDUCATION

Virtual reality can put a user "in" the scenario, such as piloting a boat. At the bottom of the screen are the mathematical formulae of acceleration and vectors. The student navigates the boat across the river through a current. The trajectory must be calculated to compensate for the current. The user can change the speed of the boat and watch the formulae change accordingly. As the learner "experiences" the changes, learning takes place on many levels, several times faster than hours or even days of lecturing does because as the teacher talks, the learner does not have the point of reference yet, not until his level of experience decodes the description being heard.

Virtual reality gives pictures to words, thus decoding. This increases vocabulary and reading comprehension because now the user has an image to go along with the word that the teacher knows is accurate. Predicting the future of virtual reality in education is like sculpting fog, but there are definite pressures that will bring virtual reality to education in the near future. There are many types of virtual reality systems. The typical reaction to what is virtual reality can be summed up in the image of "immersion".

The user of the system must have a feeling of being somewhere else. The other types of altered realities include "cab simulators" which is generally reserved for flight, military, and entertainment use where the user is enclosed in a platform which simulates a place, such as a fighter plane, that is fed pictures that induces the user to think they are in the simulation of flying or driving a tank. Projected displays are huge, wall-to-wall projections of images in which the subject could be in a cab simulator watching so much visual input that is projected around him to include the periphery that he feels he is in the simulation. Augmented reality displays are displays, typically pilots can look through and see the real world augmented with images hanging in thin air, such as targeting or radar readouts. Telepresence reality systems have been used in surgical applications to see 3D images inside the patient. At the top of the hierarchy is the immersion systems in which a user dons a head-mounted display which senses movements of the head to redraw the visual images with each movement.

The higher the number of pixels the more realistic the picture seems to the eye. Resolution near 1280 pixels by 1024 will produce pictures that approach movie quality. Polygons are the geometric mesh that texels are put in to create the texture of an object. Sound is a relatively inexpensive enhancement to virtual reality systems that derive the most depth without increasing the visual display. When systems are embellished with rich sounds, such as race car simulations where the user can hear the engine of the approaching car, hear it go by, then hear the roaring of the crowd as he passes, the picture can be just better than marginal yet the experience will be greater due to the richness of the sensory stimulation.

Tactile sensors such as gloves are often associated with virtual reality systems. But for the purposes of academic applications, it is my view that such expense is not warranted. Instead, a simple navigation device, such as a pointer or two pointers, would bring about the ability to open, close, start events, grasp and pour items, just as well as expensive haptic devices. Home virtual reality systems are the same as the academic models, built for fewer users. Once software is generated for academic use, home users could interact with schools and become a part of the total environment engaged in the "Battle of Vicksburg", for instance.

NEEDS OF EDUCATORS

In teaching, the semester or year is broken up into segments. Each segment may have several themes that expose the curriculum to students systematically. An interdisciplinary approach to teaching has proven to give the student a better understanding of the situation, the participants, the vocabulary and relationships thereof. An enhancement of that idea is to include the shared experience where small groups of students uncover thoughts and ideas about the material for themselves. This leads to a much richer understanding. Many modern classrooms are broken up into centers, each one with its own theme. Each can be thought of as its own neighbourhood with unique dimensions.

Virtual reality is the medium that could transform a classroom into any environment appropriate to the task, due to its very nature of created world architecture. Exploration and uncovering in the virtual environment is not limited to the realm of the possible. The best part of education is learning from mistakes. In the virtual environment, mistakes are not harmful and experiences can be repeated. Teachers must appreciate the fact that virtual environments teach content and processes in the same theme. While the current flight simulation technology used with professional airline pilots does not teach one to fly, it is used to ensure the integration of new sequences, thus new patterns and situations are understood.

In this manner, educators could place the virtual reality simulations either in the beginning of the lecture to build on current vocabulary skills, or with sequential data to understand dynamic functions and relational information to take back to the classroom where the teacher could begin to manipulate what was learned in the virtual environment. Conversely, the teacher may wish to lecture first, then offer the virtual environment to take the student where it may not be possible to go.

SYNTHETIC EXPERIENCE

Virtual reality uses sight and sound to create the environment while allowing the user to navigate "inside" an environment much the way we do naturally with much greater recall than simply reading or passively watching. Today pilots are required to recall thousands of sequences leading to hundreds of events without being permitted any mistakes in real-life execution of those duties. In this setting, the cost is not an issue. For military training missions, this is not the case. In the light of tremendous budget cuts, the level of readiness must be high while keeping the cost to a minimum. Training transfer has not been quantified by the military nor the airline industry due to the extreme cost of the simulators coupled with the almost constant use of the machines. The costs of these systems are near astronomical in terms of education software and hardware systems.

Using virtual reality as a delivery system for this approach is the idea behind the video games which have most children transfixed by the hour. The user is "inside" the environment, exploring the many items, manipulating them, and coming up with ideas to get to the reward. This tension built into the video game, coupled with a journey, is the most motivating aspect of gaming. In the Electronic Entertainment Exposition in Los Angeles, CA, hundreds of video games were reviewed by users and were rated by how many were purchased as well as how well the games performed.

Thousands of users responded electronically and in person as well as by other means. Those with the richest pictures and most realistic motions were the favourites. Those with the most to gain from winning were highly prized and those with the better sound effects were favoured above all the other types tried. This is no surprise to educators. Psychologists for flight simulators agree that pilots remember the richer experiences, enhanced with sound, motion, and self-directed navigation through the environment.

In addition to the need of educators to present the information in a personal situation to the student, the experience is enhanced when it can be shared with others. The shared experience tends to engage new ideas and questions brought about by collaborative investigation. The military has used this paradigm in the SIMNET system for years, where several individuals are immersed in the same battlefield scene, each with a mission. The interaction is not only with the simulation, but with each other as well. The outcome is a richer experience than being there alone. The game DOOM does the same thing for its users. There, the situation is a space station where the user is in a "kill or be killed" situation. Virtual reality delivery systems can be created to represent any situation desired. Preteaching can occur in the classroom in preparation for the virtual experience. The value of this experience was learning that the preteaching had a large impact on the outcome of the experience. Virtual reality can be used for preteaching the field trip or for remediation.

Teachers are also looking for delivery systems that illustrate:

- basic attributes,
- examples and non-examples,
- relational identities,
- classification theory,
- definition, and
- summation.

Observation is the first thing the student does, then he classifies the observations into groups, etc. The game industry has integrated all these attributes, and students learn what is required to win the game and live to fight another day.

Guidelines to Aid Developers

A system should be designed in the basic research and development model:

- Build a team to manage the project to include teachers, technical consultant, and a programmer.

- Chart the intended outcomes to include wishes and desires of teachers and users.
- Develop training transfer evaluation model.

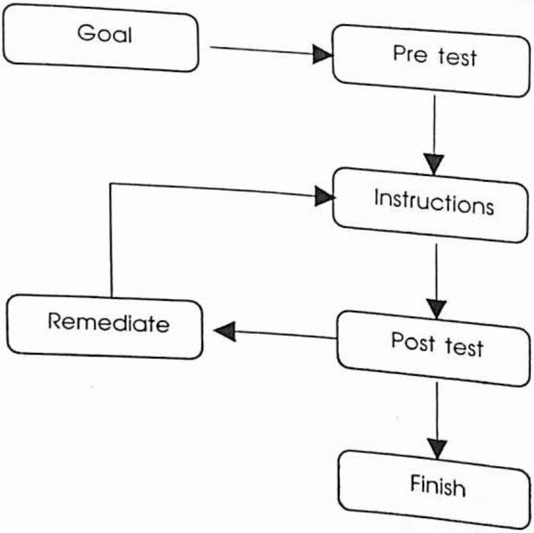
Get the requirements from the teachers who will be the recipients of the student users. Include a focus group of student users early in the design of the system.

The basic education model to be developed by the team should look like this:

CLASSROOM CONFIGURATION

A typical system set up in each school library assures that the appropriate personnel would maintain the system. The librarian would schedule class rotation to maximise usage of the system according to the needs of the teachers. This would allow teachers to use the tool before their lecture or after it, at their discretion. The home unit is simply a standard desktop computer with a head-mounted display attached.

Schedules of multiple user programming could be downloaded periodically to ensure maximum participation of the home schooler or distance learner with interaction with a school activity. Before attempting to create any new



courseware, play many games to understand where to place graphic user interfaces naturally in the virtual environment. The games that do the best job of holding the attention of the user are equipped with a guide. Keep user's orientation relative to the ground as natural as possible. This will decrease the likelihood of becoming disoriented. Persons with disabilities can benefit from virtual reality delivery systems because their physical condition is not a limitation in the synthetic experience. Mentally handicapped persons may also benefit because the system could remediate them for a specified time giving them more hands-on experience with the information.

RECOMMENDATIONS

The variables in these systems are the number of processor/headset systems needed, the amount of software development required, and the level of sophistication necessary to deliver the quality of virtual environment desired. The first components researched were the head-mounted displays. There is quite a shakedown of this manufacturing segment at the moment. Many have gone out of business this year alone.

Virtual Reality Incorporated is committed to providing wholesale to the education market. The product line is mid-range and more than adequate for home or classroom use. Forte Technologies has a headset that is comparable at the same price. They are entering the education market with a new product that is less bulky than the conventional headset which allows the choice of immersion or not.

The hardware needed to run school systems is extremely complex and needs to be developed school by school to ensure that the needs of that facility are met. Software, on the other hand, may be created almost generically as is done with textbooks. In fact, it is an extremely good idea to make as many recyclable parts of the curriculum to cut down creation times. Software houses use this technique and Sonalyst is excellent at doing so. When designing software, in accordance with the wishes of the educator, it may be desirable to build in an editor that allows the student to create their own documentaries to be the repository of what they have learned. Educators have very special needs and are the providers of the tax payers of tomorrow and deserve the very best virtual reality systems offered. As such, the systems that are designed must be: (a) in line with legacy systems of today and (b) must be so far reaching as not to be obsolete by the time they arrive at the school and the boxes are opened.

The most important recommendation that can be made to the educator is to get a development consultant early in the process. The consultant will save the school time and money from the first day. Without a consultant, teachers will have to evaluate head-mounted displays, learn how to programme for the virtual reality simulation, decide which software packages are best for which hardware platforms and what is the latest and greatest configurations and so on. It is also financially dangerous to buy a system from a vendor that only sells one brand.

The situation is akin to buying insurance from a provider that carries only one line. He can offer you only one brand. A development consultant will search for the provider that has what you, the individual educator, desires. Periodically, test the system for outdated content. Maintenance on the virtual reality delivery system is the same for any computer system. A simulation should be a journey as specified earlier with many processes included. Paradigm Simulations does an excellent job in providing high end, high resolution software applications. The headset provided by Virtual Reality Incorporated is the best value for schools or home use because it is durable and has a good maintenance record.

Virtual Reality in Schools

Many teachers have been obliged to catch up with children in the skills of using calculators and computers, and to struggle with how they should best be used in education, long after they had become commonplace in classrooms. Teacher educators have an opportunity now to learn from these experiences, and ensure that initial and in-service courses begin to prepare teachers to use Virtual Reality (VR) effectively, and to deal with issues that will inevitably arise from this new medium. The opportunity to avoid having to play catch-up will not, however, last for long.

VR IN CLASSROOMS

There have been specific proposals for ways of using VR, including: visiting inaccessible places or historical scenes; manipulating simulations of the real world, without the danger, expense or time consumption of doing the real thing; exploring places and things more effectively because of alterations in scale and time; learning algebra in a virtual world where the behaviour of objects demonstrates the axioms of algebra. Underlying such proposals for using VR in schools are a number of assumptions about potential educational benefits which are either unique to VR, or less evident in other media. Three assumptions in particular are prominent, and they focus on VR's positive impacts on spatial thinking, interest level and individual learning. If these assumptions are warranted, VR will be a powerful tool which deserves prominent coverage in teacher training.

Spatial thinking

The impact of VR on this aspect of spatial thinking is important, because children need to be able to generalise classroom knowledge to the outside world. The result is, nevertheless, intriguing because it would seem reasonable to assume a fundamental link between visualising shapes from various viewpoints and recognising shapes, or parts of them, in everyday objects. Any such link was not revealed by asking children to draw shapes, even though generous allowance was made during scoring for lack of drawing skill. This finding carries a fundamental message for teacher training. No matter how compelling a logical link might appear, it is essential to put assumptions about how children learn to the test. It is not clear what particular characteristic(s) of VR contributed to the skill of recognising shapes in everyday objects that was not available to the control group children who worked with card models.

The VR group worked much more enthusiastically than the control group, but lack of impact by VR on some tasks suggests that the gains made were not attributable solely to motivation or novelty. In another study of upper primary children, Ainge compared recall of details in a virtual scene with recall of details from a series of photographs of the scene. The scene was a single furnished room which the children explored at will. On the one hand, the intuitive expectation that a sense of actually being in the virtual room would enhance recall of all details better than photographs was not supported.

The children remembered which objects were in the room, and their colours, just as well from studying the photographs. Although the children were new to VR, were enthusiastic, and made comments about enjoying it, their enjoyment did not lead to better recall across the board. On the other hand VR had a significantly stronger impact than the photographs on children's recollection of numbers of each object (for example, there were four dining chairs) and location of objects relative to each other. There was no indication as to how VR enhanced recall of numbers of objects.

The photographs consisted of multiple views of the room, and showed the objects just as clearly as the virtual scene. Some children did, however, make comments while studying the photographs which indicated how VR may have helped them to remember positions of objects. Although the verbal instructions made clear that the 18 photographs were all of a single room, some children revealed that they were visualising more than one room. This did not occur with the virtual room. In VR it was possible to see at a glance that there was only one room, but some children clearly had difficulty in synthesising the photographs into a whole.

These findings strongly suggest that aspects of teacher training which deal with the development of children's spatial thinking, in particular, but not limited to, mathematics, should inform teachers about the significant contribution which VR can make.

Interest level

VR does not entertain in the way that a film or video does. The display of a virtual scene remains static until the user makes things happen, by exploration or manipulating objects. The novelty of the technology appealed to the children and they were anxious to become involved. More significantly, however, it was found that interest remained high even after several experiences, without any sign of reduction.

Pantelidis led a group that produced virtual reconstructions of a native North American Indian fort, using VIRTUS WALKTHROUGH. Middle School children were given a lesson about the fort, then explored the reconstructions. Pantelidis reports that the children were very enthusiastic and wanted to find out how the Indians had lived. Ainge, in the study of VR's impact on learning about three dimensional shapes, found that the children, who normally tended to participate reluctantly in classroom activities, maintained their enthusiasm over a period of six weeks.

Throughout the work with VR, not one student required any encouragement to remain on task, and many were reluctant to stop when their session came to an end. The teacher was impressed by the high level of student engagement and enthusiasm, which contrasted sharply with the response to other classroom activities. Each student was interviewed at the completion of the study, and responses indicated a unanimous feeling that VR had helped them learn, a high level of enjoyment of VR, and strong maintenance of interest.

Fifteen children reported after six weeks that VR was at least as enjoyable as when they first began and seventeen said that they preferred learning with VR rather than other activities. Given teachers' widespread concerns about difficulty in motivating children to participate effectively in classroom activities, it is imperative that teachers be made aware of VR's strong potential for engaging pupils. Given that there is only limited understanding at this stage of VR's educational potential, teachers in training should be encouraged to join the research effort and seek to identify a range of activities which could be made more enjoyable by the use of VR.

Individual learning

According to Ferrington and Loge, when children actively pursue their individual strategies for exploring virtual scenes, they should learn better than when they take a passive role in the classroom. They anticipate that learning will combine cognitive, affective, and psychomotor skills as children pursue their own learning strategies. Apart from finding that after the VR practice the children were significantly faster and more accurate in real world shopping, they investigated change in self-directed activity. They found that over the period of the VR sessions there was a significant decrease in teacher input, and in particular, instruction and physical guidance decreased at a faster rate than more open ended assistance.

Some children moved about slowly, as if they were cautious, and sometimes were startled by movements. The boys tended to make more rapid movements than the girls, although this did not apply in all cases. Some children referred to flying and enjoyed zooming in on shapes at high speed. A virtual hand was available, controlled by the mouse, and it could be made to grasp shapes and move them around or rotate them. Some children used the hand whereas others practically ignored it. Some children took the option of switching it off. At times, all children made movements which resulted in their shapes disappearing from view.

The way that children addressed this problem revealed a range of approaches from impulsive to thoughtful. Some children gave a running commentary on what was happening, others said very little. When the children were asked about their work with VR, their responses indicated that they had interacted with VR in individual ways. They each had their own views on how VR had helped them learn, ways it could be improved, and what they liked most and least, about it. The view that learners not only should, but inevitably do, construct their learning, rather than simply acquire information, is widely accepted. The implication of this view is that when children are not actively constructing learning, little, if any, learning takes place.

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Learning in Cyberspace

Contemporary technological convergence negates this paradigm, was the subject of research at Ngee Ann Polytechnic in Singapore. Parameters of the experiment were established to include resources designed to improve learning by promoting student motivation. Contemporaneously, researchers sought to identify whether particular elements of information technology (IT) design, increased or reduced motivation more than others, and this was achieved by paying careful attention to the following five factors which were identified as potential motivators for students in an IT environment:

- opportunity for responsive feedback and individual involvement;
- the presence of motivating instructors;
- learners being active—able to make their choice of pace and content;
- collaborative learning; and
- curiosity and self discovery.

Each of these separate factors were adapted as design elements and incorporated into the internet site used in the experiment.

OPPORTUNITY FOR RESPONSIVE FEEDBACK AND INDIVIDUAL INVOLVEMENT

To provide students with responsive feedback and individual involvement, internet e-mail and teleconferencing were therefore built into the site design. Students were offered internet e-mail access to lecturers, and a bi-weekly teleconferencing meeting was also available for their use, whereby students could participate in electronic chat sessions with staff and fellow students.

Motivating instructors

A teacher who cannot motivate students in the conventional classroom is likely to face the same situation using computers. The multimedia and internet programmes were therefore designed by motivating instructors, to encourage students to learn. The lecturing staff therefore encouraged students and demonstrated a passionate commitment to the internet site.

Learners being active—able to make their own choice of pace and content

The premise of this design element was the work done by Pintrich et al., that "when the instructional focus is on practice, rote application of rules and adherence to teacher specified activities, students place little value on the tasks and display less motivation". It was felt that by giving students this choice, motivation, commitment, deep involvement and strategic thinking about tasks, would improve. Students were permitted to choose the path, content, pace and nature of the material, within a 'framework of guided discovery'.

Collaborative learning

The internet site design therefore incorporated Class Home Pages, whereby students in each class would work on projects, and post the results of their work on to the Class Home Pages for review by their peers. Paris and Turner also hypothesised that "peer observations and insights often surprise fellow classmates who may have never considered a concept in a way advanced by a classmate".

Curiosity and self discovery

It was also suggested before the research work began, that "curiosity is an important element in attaining and keeping the learner's attention". The internet site design therefore enabled the introduction of many changing facets, unavailable with traditional course delivery methods, such as on-demand videos and graphics.

Teaching and learning

During the design phase of the experiment, the traditional teaching and learning dichotomy also became a relevant issue for the key design decisions. The question to be resolved was whether the internet site design should focus primarily on learning outcomes or teaching facilitation. There are competing viewpoints on education. Instructionists advocate the traditional belief of education, whereby students learn better through improvement of teaching instruction.

Students are passive, while teachers are active. Antithetically, constructionists, believe that students advance through discovery and participation—learning and remembering, by discovering the specific knowledge they require and not simply receiving it from others. To improve this learning process, constructionists maintain that minimal structured individual guidance from teachers is needed. In this context, IT resources, as an adjunct to human teachers, continue to confront educators with opportunities and challenges. Constructionists and instructionists continue to debate the relative merits or otherwise of IT in support of their respective points of view. For example, constructionists hasten to add, that teachers cannot be replaced with computers. Teachers are extremely versatile and adaptive—their pedagogic ability greatly exceeds any computer-learning packages. It is contended that this debate is largely irrelevant in an IT environment, and that educators need to distinguish multimedia as a facilitator of learning, rather than teaching.

The concepts of 'teaching' and 'learning' are seen as separate elements of an education closed-loop model that is borrowed from control engineering theory. It contends that teaching is in the forward path of a closed-loop education system, and that learning (and hence tutoring) is in the feedback path. In this model, teaching takes place using 'information' prescribed in a syllabus. Teaching is seen fundamentally as a process in which a large amount of information is compressed and delivered by the teacher to the students in limited lecturing hours.

Learning on the other hand, is a slow process of digesting and converting information to knowledge and skills, both during and after lecture hours. Consequently, physical attendance at a lecture by a student does not necessarily mean that learning is taking place or taking place efficiently. Learning efficiency varies from student to student and is largely influenced by students' capability and motivation. Hence, motivation is represented in the feedback path as a switch. When student motivation drops to zero, the feedback path is switched off.

The system becomes an open loop. Teachers receive no response from students and will try to work frantically, leading to over teaching. In order to avoid an open-loop situation, it is important to 'kick start' the learning process through motivating and helping students to learn. Once the closed-loop is reestablished, teachers begin to receive good responses and feedback from students. Teaching becomes less tedious and professionally more fulfilling. Students begin to recognise their own small achievements which help to further strengthen motivation. In control engineering terms, the education loop is in a 'tracking control mode'. The teaching function must always be a human one.

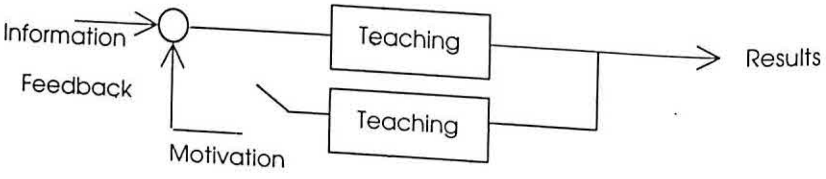

Figure 1: Closed teaching/learning loop

Teachers are more flexible and efficient compared with computers, when delivering a large amount of information, in digestible form, in a short period of time. Programming a computer to deliver digestible material to replace a teacher is very time consuming and costly. Hence the use of technology as an adjunct to human teachers is more efficient and practical than replacing human teachers with technology. Since learning is a slow process, computers can be used to help in the learning/ tutoring role just like human tutors are employed to help teachers, hence assuring that the feedback mechanism is in place, motivation is high and therefore teaching becomes more rewarding and productive. This view became fundamental to the design of the IT-based educational materials used in the Singapore experiment, and this research, *inter alia,* sought to substantiate this model, and the consequent implication thereof, that educational effectiveness was thereby enhanced by a strategy of maintaining good teaching by human teachers, conjointly with innovative and motivated learning—learning which involves IT multimedia.

Research

Ngee Ann Polytechnic in Singapore offers Diploma level courses in 11 departments, and provides learning for 15,000 students, drawn from Singapore, Malaysia, Thailand, Indonesia, China, and Taiwan. A total of 800 staff is drawn from around the world. During 1997, the Accountancy Department agreed to research the implications of implementing internet education as an adjunct to existing course material in the first-year subject, Financial Accounting. To support this trial, an internet site containing 800 pages of course material was developed.

The course material was converted to HTML format from standard word processing documents produced in prior semesters. The process of conversion was done using Microsoft Publisher, and required approximately 350 man hours. The total cost of creating the 800 page site was approximately US$ 14,000. The trial was then limited to an experimental group of 111 students from the first-year cohort of 444 students. The experimental group comprised six classes chosen at random from the 24 classes making up the cohort of 444 students.

The selection of students in these classes was undertaken by the Department's Grouping Committee, prior to the decision being made to start the experiment. The Research team had no involvement in this selection process and the students chosen were as far as possible representative of the entire cohort. No pre-screening of students with minimum computing skills or computing experience was carried out.

To provide additional research material, a concurrent trial was also undertaken with a group of 40 students who had previously failed Financial Accounting, to determine whether the internet also impacted the learning skills and results of these 'weaker' students. The trial began in July 1997, and the data presented in this report is up to and including October 1997. All internet material was made available to students from the start of the semester. In the first week of the trial, students in the experimental group were introduced to the internet site in both a special lecture and a subsequent tutorial.

During each subsequent tutorial, a minimum of 15 minutes in each two-hour class was used to point out resource material available on the internet site. At the end of each tutorial, personal e-mail messages were sent by the lecturing staff to students who performed well, and also to those who appeared to be struggling with concepts or material during the previous class. These messages focused students on relevant material on the internet site, suitable to their progress. At the end of each week of classes, Frequently Asked Questions were released on the internet site along with answers to those questions. This enabled sharing of information amongst the students in the experimental group, irrespective of class.

The experimental group students were also provided on the internet, with material beyond the core curriculum, particularly more advanced readings, and more difficult questions—which incorporated content from all previous weeks' topics. In addition, each week, students in the experimental group could work through Multiple Choice Questions which focused on basic principles. Each class was invited to appoint a Class Webmaster and then create a Class Home Page on the World Wide Web.

The objective of this innovation was to remove fear of the internet and encourage more regular use. These Class Home Pages were adopted by all classes, and were located as separate pages within the Financial Accounting site, to further maximise ongoing student exposure to the site. Twice weekly, after hours, additional tutorials were conducted (under the chairmanship of the lecturer), for interested students by teleconferencing using Microsoft NetMeeting. During these online evening chat sessions, students asked text-based questions of one another and the lecturer. During the coming semester these sessions will be expanded to include audio and video support. In line with departmental objectives, learning was to be a 24-hour per day opportunity for students, thereby effectively dictating use of the World Wide Web to deliver the relevant course material and other resources, and enable students to access from home as well as at campus. To assist students in the experimental group, computer laboratories were upgraded and the latest versions of all popular browsers were installed.

Computer laboratories were made available up to 9 pm each day. In the coming semesters it is planned to issue more students with 'on-loan' notebook computers, and work is currently underway to provide login ports in the student canteens, library and open study areas. In terms of content and structure, the internet site was designed to offer three streams of learning, and within each of these three streams to offer different strands.

The chosen streams were for slow learners, average learners and advanced learners. Students had complete freedom to choose which of the above strands to access, and could move freely between the strands. However, the site was designed to subtly keep students in one of three 'learning streams' until they, by their own choice of material, indicated they were ready to move to the next stream. This was achieved by judicious use of the web page buttons at the bottom of each page on the site. If a student entered the site and initially chose a strand in the 'Slow Learner' grouping, then the web page buttons on that page, only offered other strands within that learning stream.

For example, if a student accessed Multiple Choice Questions (thereby indicating the student was more comfortable in the slow stream), then the web page buttons on that page only offered 'Lecture Notes', 'Tutorial Questions' and 'FAQ's' (i.e. other strands within the same slow stream). This element of design thereby built on the notion of providing students with a 'framework of guided discovery'. The design concept was to keep resources at the student's fingertips, which were most appropriate to the current level of progress. However, any student could theoretically access any material at any time by reverting to the main index and selecting material at any level—the 'streaming' was thus not transparent, but took place discretely.

ACADEMIC RESULTS

The examination required both computational and theoretical questions to be answered. Three questions were set for completion in two hours. Examination papers were then marked by lecturers other than those involved in the research project. The hypothesis to be tested was "that examination results for the experimental group (using the internet) were superior to the control group (those not using the internet)". In order to test this hypothesis a one-tailed test for the difference in means was undertaken.

The test statistic (z) of 4.448 derived from this test is significant at the 0.1 per cent level. Accordingly it can be concluded with an exceptionally high degree of confidence, (99.9%), that the examination results of students using the internet site as an adjunct to learning, was superior to students who did not use the internet site. As indicated earlier, a concurrent trial was conducted with a class of weaker students, enrolled for another Financial Accounting subject. These students had already failed Financial Accounting at a previous attempt. This experimental group of 40 students, were introduced to the internet site as an essential element of their learning in semester. As all students in this class were included in the experimental group, it is only possible to compare their examination results with prior years.

Hence it is not meaningful to draw statistically sound conclusions, due to the fact that 'other factors' may have influenced results. However, *prima facie* results, indicate that these 'weaker' students achieved a significant increase in examination results, which appears attributable to use of the internet as an adjunct to learning. *Prima facie*, the improved results appear even higher than for 'average' students, and this is especially encouraging for educators. The following additional data was gathered on use of the internet site during the last four weeks of the semester, by the 111 students in the experimental group.

Table 1

Statistics of internet usage

	Total hits	*% of all hits*
Powerpoint lectures	25	2.0%
Detailed lecture notes	241	20.4%
Lecture examples	30	2.5%
Variations of lecture examples	11	0.8%
Tutorial questions	354	30.0%
Tutorial solutions	210	17.8%
MCQ's	75	6.3%
Frequently-asked-questions	90	7.6%
Additional questions	40	3.3%
Library references	25	2.0%
Advanced readings	5	0.3%
Comments from practitioners	80	6.7%
Advanced questions	5	0.3%
	1,171	100.0%

A web-counter facility was not installed until late in the semester, and so there is no record of which particular students used the site, hence the possibility of the results being distorted by a small number of students using the site regularly cannot be completely discounted. Analysis of Table 1 indicates that students accessed pages offering theoretical material for 22.9 per cent of all 'hits'. This is a disproportionate usage in comparison with the total curriculum balance, indicating that the internet is fulfilling a learning gap not easily satisfied from other sources readily available to students. There is some conjecture that this result may be attributable in part to the natural curiosity of first-year students to learn how to approach and answer conceptual questions.

Proponents of this view will undoubtedly argue that as such students become more familiar with these new skills, they will access these pages less, instead electing to concentrate on computational pages and skills. Ongoing research is necessary to respond to this view, but in the interim, results point strongly to improved conceptualisation skills arising from this high usage of 'theoretical' site pages. This has been measured by the 8 per cent higher number of students in the experimental group who exhibit minimum levels of understanding of accounting concepts, compared with the same number of students in 1996 from a non control group.

This result is very encouraging for first-year polytechnic students who have traditionally found theoretical accounting concepts difficult. Anecdotal evidence points toward tile cause of this improvement as being due to the 'streaming' design of the internet site. Advanced students (i.e. 'A' grades), were measured at a 14 per cent improvement in conceptualisation skills, and struggling students (i.e. 'D' grades), at a 12 per cent improvement. Average students (i.e. '13' and 'C' grades), were however recorded at only a 2% improvement. This result suggests that tile stronger and weaker students are finding course material oil the internet more appropriate for their respective levels of understanding, and are therefore more interested and motivated to understand and absorb that content.

Average students are not finding the same opportunities—a challenge for future site revisions to address. For first-year students, the inability to conceptualise complex new issues such as 'Inventory Valuation' and 'Cost of Goods Sold' has been a significant barrier in prior years. This research result indicates that higher conceptualisation skills are achievable by direct intervention in learning environments.

The internet provides resources to achieve that intervention, and to enhance the process virtually on a student by student basis. From this basis, it is possible to move confidently forward into more innovative intervention and direct research into the commercial environments as well. It should be possible to use innovative and stimulating internet learning environments to impart new skills (both conceptual and computational) to accountants in industry.

TEACHING PRODUCTIVITY GAINS

The improvement in academic results already reported in this paper are, in their own right, reason enough to push ahead with further development of internet-based accounting course delivery at Ngee Ann Polytechnic. Unexpectedly however, this work unearthed an equally important benefit, of tangible and direct value to education administrators. Teaching productivity increased with immediate effect. At this point, it should again be emphasised this was at no stage an objective of the internet site, and all design features were focused on maximisation of learning, irrespective of teaching implications.

The definition of a change in teaching productivity used was the percentage of semestral time spent in student support or teaching activities, compared with the percentage of time spent in non-student support or non teaching-related activities. Measured teaching productivity gains of 16 per cent were achieved in the semester following launch of the internet site. Weekly time sheets were kept by the lecturer in charge of each group of students, according to the following dissection.

The data is hence only as reliable as the memory recall or accuracy of recording on a weekly basis. The hours reported in Table 2 are the aggregates over the 13-week semester. Some effect from the high preparation load imposed the previous semester by the shift to IT must be present, and hence it is not possible to conclude other than an indicative result until another semester has elapsed and there is more comparability in this data.

The initial assessment however is of such magnitude as to warrant interim and immediate disclosure in this paper.

Time previously spent on typing of lecture and tutorial material decreased from 16 per cent to 4 per cent. This arose as a direct result of having the relevant course material, particularly lecture examples, past examination questions, and past tutorial questions, already prepared on an IT platform on the internet site, thus enabling rapid modification to suit the demands of students each week, and enabling rapid preparation of questions with slightly varied data content.

Table 2

Productivity gains

	Student contact/ teaching related		*Non-student contact/ non-teaching*	
	Trial period	*Previous semester*	*Trial period*	*Previous semester*
Class contact	24%	22%		
Student consultation	12%	6%		
Staff meetings			1%	3%
Exam administration/marking			3%	3%
Curriculum development	30%	26%		
Typing lecture notes/materials			4%	16%
Lecture/tutorial follow-up			7%	10%
Student e-mail contact	5%	1%		
Internet site administration			5%	0%
General administration			8%	10%
Professional development			1%	3%
Total	71%	55%	29%	45%

The time released from these otherwise cumbersome manual and administrative tasks could then be directed towards increased student contact hours, both at face-to-face contact level and e-mail communications. In particular, time devoted to individual and small group student consultation increased from 6 per cent to 12 per cent. Productivity gains of this magnitude are of course very significant when extended across a campus of 800 lecturing staff. If such gains were translated into all other Departments at only 25 per cent of this level, then each student on campus could have 2.5 hours per semester of 'one to one' consultation with a lecturer.

Personal contact hours at this level would have an immediate positive effect on academic results and the quality of education provided at Ngee Ann Polytechnic. The challenge for administrators, is of course to translate such productivity gains into student contact hours, and not let them be 'lost' in alternative administrative activities.

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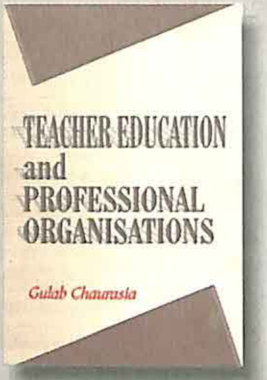
TEACHER EDUCATION
and
PROFESSIONAL
ORGANISATIONS

Gulab Chaurasia

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TEACHER EDUCATION and PROFESSIONAL ORGANISATIONS

Teacher education plays a unique, pivotal role as mother of all professions— which is the basis for shaping mankind. Professional development of teachers has received a great deal of attention all over the world. The goals of continuing professional development are to advance students' learning and improve the practice of teaching.

If teacher education is to attain true professional status, individual teacher educators, colleges and departments of education and teachers unions have each to reconceptualize their respective roles. The call for dynamism in teacher education is timely and it should continue to ring loud and clear for a comprehensive, well planned, concerted and sustained reform of the profession to meet the changes ahead.

Our priority agenda in this book is to prepare teachers for the new millennium. We also try to identify some of the more important key issues which are central and which should be dealt with afresh, so that teacher education responsibility leads the way to prepare worthy, competent, humane teachers and citizens for the global society of tomorrow.

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